THE TECH ENGINEERING NEWS

VOLUME XXV NOVEMBER, 1943 NUMBER 2

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Dec. 7th 1943

THE STORY OF BLOOD PLASMA TOLD IN PICTURES

WITH A MESSAGE FROM PRESIDENT COMPTON

Skillful Hands

behind his Trigger Finger

Men's hands, women's hands, white hands, black hands—millions of them in all parts of the country—in scores of different industries—are backing up the trigger fingers of our fighting men.

Hands that are grimy—hands that are clean—hands that put thoughts on paper—hands that turn blueprints into planes, tanks, trucks and guns—hands that farm and sew and sooth—all are playing important parts in winning a tough and stubborn war.

And thousands of these skillful hands are toiling in Eaton plants. They are making Sodium-Cooled Valves and other fine precision parts for airplane engines. They are making many critical parts for war equipment of many kinds. They are helping to perform the greatest miracle of war production the world has ever seen.

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More United Nations armies need *more* fighting tools and ammunition every day. *More of everything* is needed—quickly—to keep ahead of faster combat schedules.

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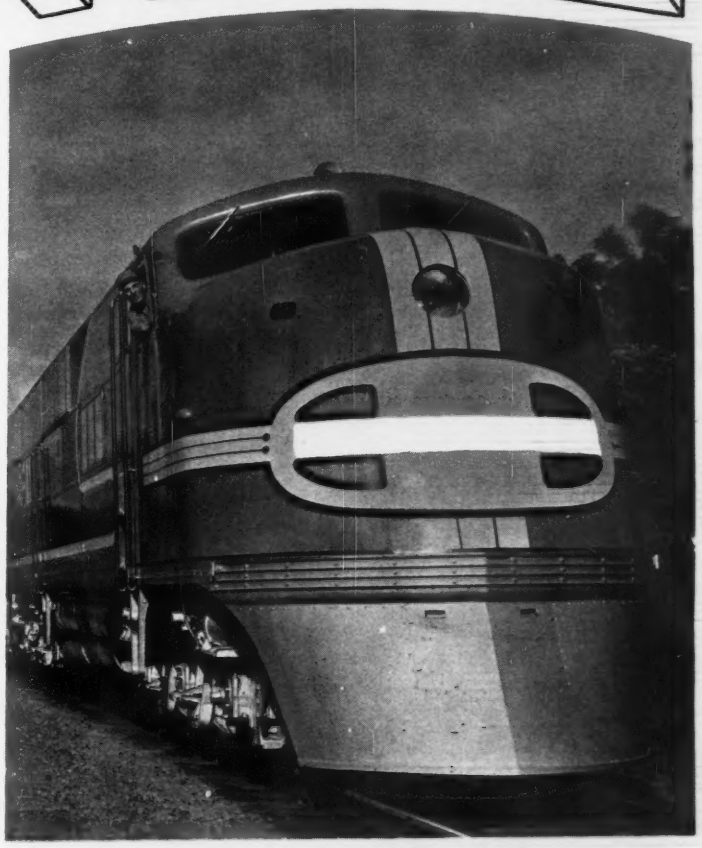
All America is Talking

DIESEL

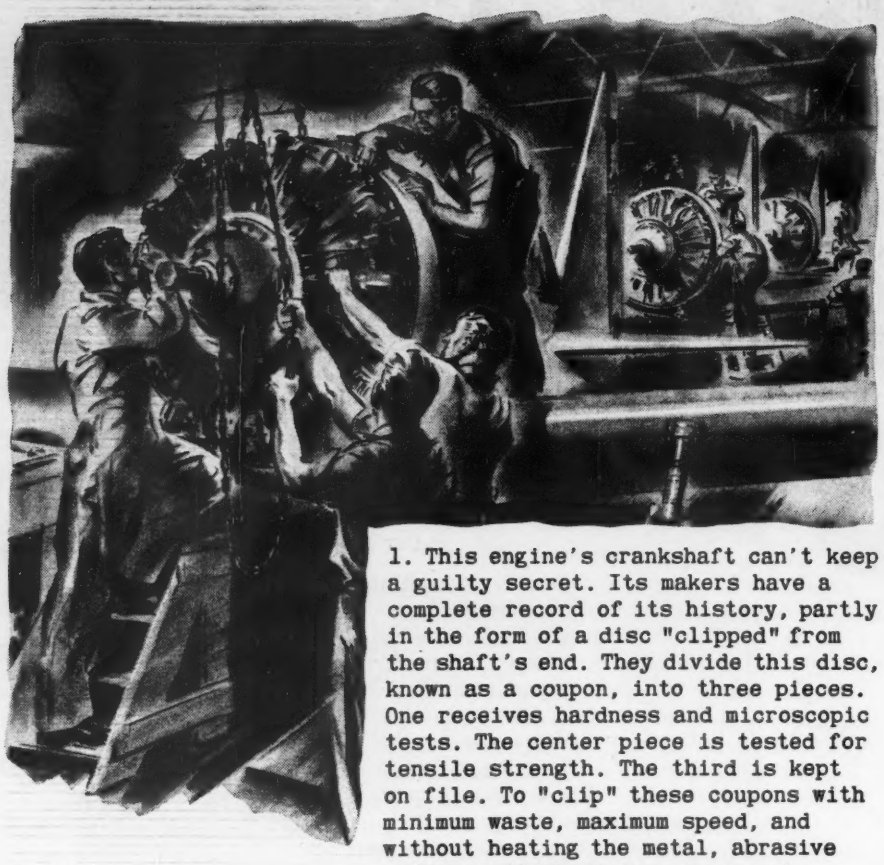


DIESEL

PERMANENT MOLD

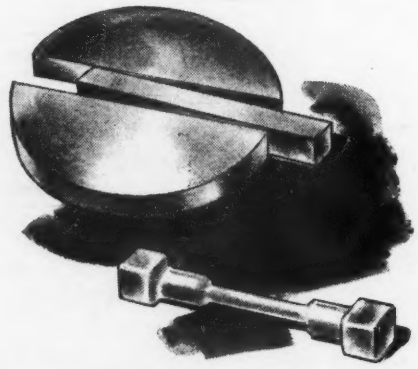
MOOSUP, CONN.

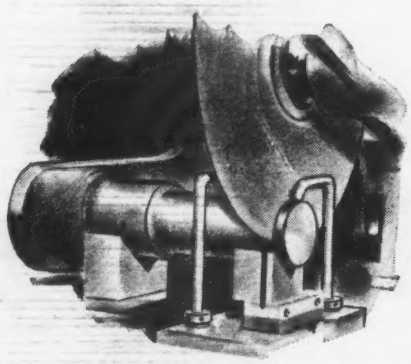
Clipping coupons from airplane engine crankshafts!



1. This engine's crankshaft can't keep a guilty secret. Its makers have a complete record of its history, partly in the form of a disc "clipped" from the shaft's end. They divide this disc, known as a coupon, into three pieces. One receives hardness and microscopic tests. The center piece is tested for tensile strength. The third is kept on file. To "clip" these coupons with minimum waste, maximum speed, and without heating the metal, abrasive cutting off wheels are employed.

2. With speed and precision counting for so much these days, abrasive cutting off wheels by Carborundum are coming into far wider use. In seconds they perform jobs which require minutes by ordinary methods. Such wheels are now used to cut plastics, glass, brick, tile, steel and non-ferrous metals in plate and bar stock faster and more accurately than they were ever cut before.





3. In industry you may run into abrasive applications that may be strange to you. When and if you do, remember that Carborundum is ready to help you solve your abrasive problems. The Carborundum Company, Niagara Falls, N. Y.

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ABRASIVE PRODUCTS

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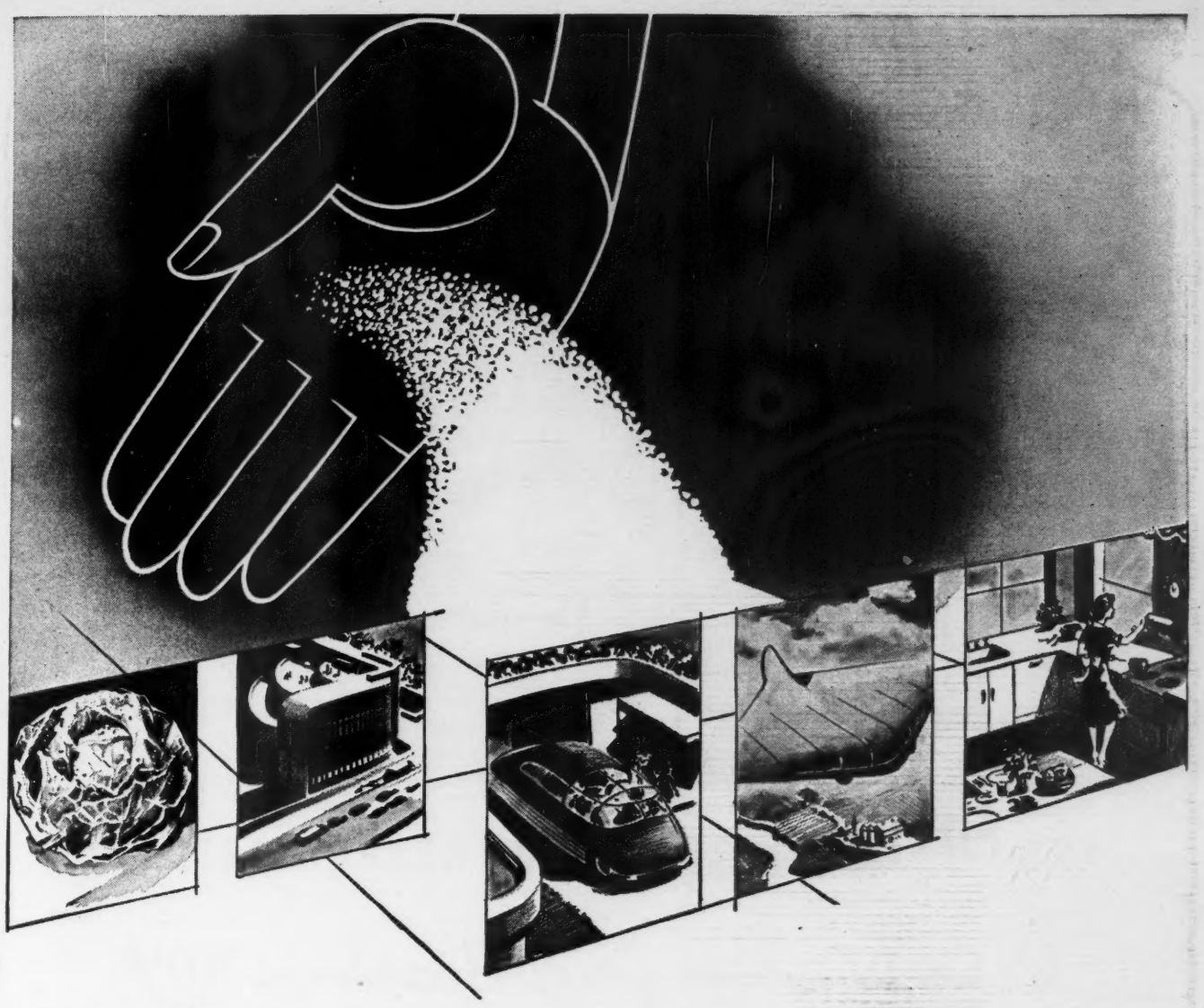

PLASTICS—products of industrial initiative

Plastics are a stimulating source of inspiration for architects and industrial designers in search of new ideas. When these intriguing materials are released from their military commitments, innumerable applications for the home front will arise. No products offer a better example of how progress can be accomplished when industry is given free rein to its initiative.

As a producer of basic chemicals needed for the manufacture of plastics, Dow is in a particularly fortunate position to promote their development. Three major Dow plastics—Styron, Ethocel and Saran—have already been produced. They possess distinctive properties that permit a bewildering array of uses in almost every field of human activity. There are also varieties of Dow plastic materials for coatings, finishes and other purposes in the electrical, textile and many other industries.

These plastic products do more than supplant other materials. They are veritable points of departure that lead to fresh fields. When normal conditions return, self-reliant industry, expanding on its own resources, will develop and apply them for the greater well-being of all America.

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DOW

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The world of the future will be a world of wheels and wings to an extent that cannot be completely foreseen now. But one thing is sure—it will be a world of bearings, too, for wherever wheels or shafts turn, they must turn on bearings.

It is not too much to say, in view of their present dominant position, that it will be a world of Timken Tapered Roller Bearings; for there is no bearing requirement that Timken Bearings cannot meet.

So, while you are still studying, learn to know your Timken Bearings thoroughly —their design, application and potentialities. Then you'll be still better equipped for your job when college days are over and you take up the responsibilities of a full-fledged engineer. The Timken Roller Bearing Company, Canton, Ohio.

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TAPERED ROLLER BEARINGS

THE TECH ENGINEERING NEWS

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OFFICE OF THE PRESIDENT

To Readers of the T. E. N.:

I do not need to stress to any Technology group the importance of the Red Cross Blood Bank and the urgent need for the largest possible number of physically qualified donors. Large numbers of Technology people have contributed through arrangements made by committees of the staff and student body, and many have donated in response to appeals in their home communities.

The record to date is fine and we may be proud of our community participation. At the same time I am glad to see the need and opportunity for donations reemphasized by this issue of Tech Engineering News. We can well be reminded that our responsibility is a continuing one, that the need for plasma daily grows greater, and that indeed a desperate shortage exists. I am sure that Technology will continue to respond to this need with increasing generosity.

Sincerely yours,

Karl T. Compton

President

October 21, 1943

FIGHTING BLOOD

By CURT B. BECK, 6–45
Editor-in-Chief, The Tech Engineering News

ONE of the most worth-while privately sustained projects in the present World War is the American Red Cross drive for blood donations. Civilian donated blood has meant more towards the preservation of life and morale in our Armed Services than any other of the Home Front auxiliary measures, and as such represents a cause toward which every American should contribute.

The life of this drive depends upon each individual contribution of blood. In order to make a contribution, the donor calls his nearest center* (or any one of the mobile units which are sent out from the center) and makes an appointment. Upon arriving at center he awaits his turn, answers a few questions by a registered nurse concerning his health, and is conducted to the blood-letting room. His arm is anesthetized and the blood is taken, as shown in the accompanying pictures. The entire process is painless. Doctors agree that, if anything, it is beneficial to lose a little blood, as it gives the system a toning-up. (This fact was recognized by medieval surgeons, who sometimes carried it to extremes.) After the donation, the donor rests a few minutes. The whole procedure usually takes about forty-five minutes, a fraction of the time required for the complex procedure of conversion to plasma and delivery to the front.

Although the modern process for conversion of blood into plasma has just been perfected within the past ten years, its importance is as great as if it had been known for the past century. Even before war broke out in 1941 the United States Army and Navy requested the Red Cross to supply 15,000 pints of blood to be treated by the new process and tried out in actual warfare conditions. Then came Pearl Harbor, and by the end of 1942, 1,300,000 pints of blood had been delivered. But the 4,000,000 pint quota for 1943 is far from being attained. The importance of whole-hearted support of this drive is well brought out by the accounts of its wonderful effects upon front-line surgery and morale. Everyone between the ages of 21 and 60 weighing over 110 pounds, and between 18 and 21 with their parents' consent, can donate.

The story behind blood plasma is one of the more interesting of modern medical epics. It all goes back to 1900, when a young chemist discovered why blood from one patient threw another into violent convulsions yet saved the life of a third. Following the discovery of the different blood types, in 1915 a doctor was at last able to keep blood for a period of time by adding sodium citrate to it. In consequence of the difficulty involved in keeping the different types of blood preserved and handy for transfusions, a medical officer made the suggestion that the plasma portion (that portion of the blood with the corpuscles removed) might be just as useful as the whole blood. It was not until 1925 that anything was done with this suggestion. At that time Dr. Max Strumia, a young pathologist, decided he was going to investigate the possibilities of using plasma in place of blood. After finding it harmless to rabbits, he tried it, a little at a time, on patients who were beyond hope. While it didn't save any of them, it didn't harm them, so the next step was to try giving large transfusions of plasma — enough to restore the blood pressure of a stricken patient to normal. The first actual large-scale transfusion was successful, but, since it was carried out on a hopeless case, only prolonged the life of the subject a few days. However, in 1934, plasma transfusions were used on a boy dying of a blood-stream infection. The transfusion saved his life, and now its use is standard medical practice.

Still an impediment remained to the universal use of plasma. While research workers had proven that it did not harm its usefulness to ship it all over the world or subject it to cold, heat, or rough handling, the liquid, as did serums and vaccines, lost its potency after a certain period of time. The problem was attacked by scientists and biologists all over the country, and, in 1938, the process of drying and using plasma as such was perfected, as shown in the accompanying pictures.

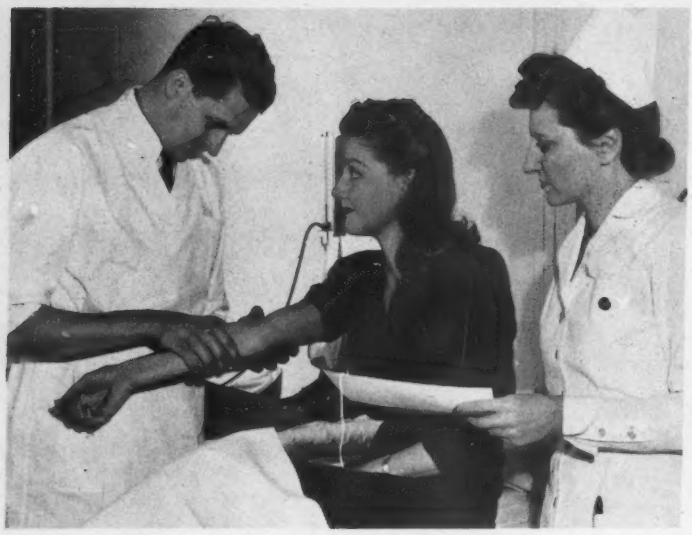
Then, in 1939, war struck. The British Army Medical Corps were relying, at the outset, upon elaborate refrigerator trucks for rushing whole blood to the front for emergency transfusions, but these soon proved quite inadequate under actual battle conditions. American military observers noted this, and at once asked the National Research Council to develop a suitable substitute for whole blood. Dr. Strumia was given the job, and he recommended dried plasma. After extensive tests, which proved its suitability beyond a doubt, the wholesale production of dried plasma began. It was first tried out in the army war games held in the Carolinas, and there proved its usefulness beyond any doubt. When war threatened in the Pacific the Army and Navy requested 200,000 blood plasma units, increasing this to 1,000,000 after Pearl Harbor. The job of collecting this was accepted by the American Red Cross, who set up blood donating centers in Boston, Washington, Chicago, Los Angeles, St. Louis, San Francisco, Pittsburgh, Milwaukee, Rochester, Detroit, Buffalo, Indianapolis, Cleveland and Cincinnati.

The results of having blood plasma introduced in this war as a medical auxiliary are striking and gratifying to those who have donated or are going to donate blood to this worthy cause.

Some of the most serious casualties produced by

(*Continued on page 58*)

YOUR BLOOD



Ann Sheridan Donates . . . Why Don't You?

After answering a few simple questions concerning her health, Miss Sheridan is given a preliminary examination. This includes temperature, pulse, blood pressure, and hemoglobin count tests.

Photo, American Red Cross

(Above)

Seventy-Eight Pints of Blood in Twenty-Six Years

That's the record of Carl C. Neuman, 49, shown here making his most recent contribution at the District of Columbia Red Cross Donor Center. Sergeant Neuman made his first blood donation as a Red Cross worker in France in 1917 to save the life of a wounded soldier, and has continued this generous practice ever since. Sergeant Neuman lived in Winter Haven, Florida, where citizens boast that half the people in that county have some of Carl Neuman's blood in them. Never once, he says, has he felt an ill effect from his own donations.

Photo, American Red Cross

Bares Her Arm for the Armed Forces

Blood Donor presses gauze against her elbow following donation. The Band-Aid on her arm will be a service ribbon to show that she was one of the four million donors sought by the Red Cross to meet Army-Navy requirements for 1943.

Photo, American Red Cross

Into Refrigerators

Here the blood is being packed into refrigerated containers to be shipped to the processing laboratory. Each container holds eighty-five pints of blood, which must reach the processing center within twenty-four hours of being drawn from the donor's veins.

Red Cross photo by Johnson

GOES TO WAR

Sealing the Bottles

Here the frozen plasma is sealed into individual bottles for hydrating.

Photo, American Red Cross

Unloading the Blood at the Laboratory

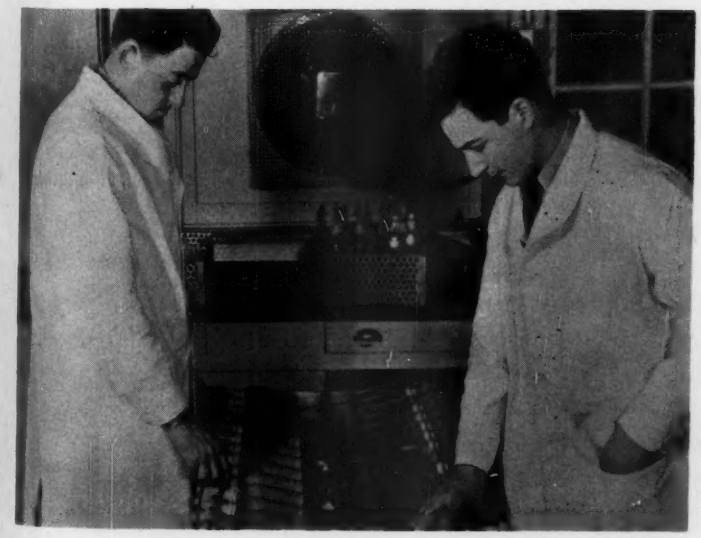
Each of these huge refrigerated containers holds eighty-five pints of blood donated to the Red Cross for processing. The blood is shipped daily from the eighteen Blood Donor Centers participating in the program, and must reach a laboratory within twenty-four hours after it is drawn from the veins of the donor.

Red Cross photo by Johnson

Separating Blood Plasma from the Corpuscles

Here the individual donations are being taken out of a huge centrifuge, where they were whirled at 2500 rpm for one hour. This process drives the red and white corpuscles to the bottom, leaving the clear plasma at the top. The plasma will now be siphoned off, frozen, and reduced to a dried flaky powder.

Red Cross photo by Johnson



Freezing the Plasma

Freezing must take place seventy-two hours after bleeding, and is done by rotating bottles of plasma in trays of dry ice and alcohol. Frozen plasma looks like frozen orange juice.

Red Cross photo by Johnson

Huge Vacuum Tanks Turn Frozen Plasma into Dried Flaky Powder

These huge tanks are turning frozen plasma into dried plasma. In each tank are placed several score bottles of frozen plasma, each bottle containing plasma from an individual donor. The lid is fastened down, a huge vacuum pump is set in operation, and the moisture in the frozen plasma is drawn off, leaving a light, straw-colored, flaky powder.

Red Cross photo by Johnson

Plasma Being Nitrogen-Sealed in Cans

In the finishing room plasma is sealed in cans, after which it will be packaged and shipped to the United States Armed Forces throughout the war zones. In the photo above, the bottles of plasma and distilled water together with the tubes and needles necessary for a transfusion have been placed in the tin cans. Each can will be placed in a special machine which pumps all air from the containers and replaces it with nitrogen to prevent deterioration of the rubber tubes. Already, human blood plasma has been credited with saving hundreds of lives of our soldiers and sailors. Over 2,888,000 donors will be required to furnish the 4,000,000 pints requested by the Army and Navy from the Red Cross.

Red Cross photo by Johnson

Life-Saving Plasma for the Army and Navy

Here is a pint of blood after it has been processed and dried for shipment. The bottle at the left shows the dried plasma and the other bottle contains distilled water. These two bottles and tubes and needles in front are hermetically sealed in the tin cans shown in the background, and will last indefinitely without deteriorating. In transfusions on the battlefield or on ships at sea, the cans can be opened, the plasma dissolved in the distilled water, needles inserted, and the transfusion given, all in approximately fifteen minutes.

Photo, American Red Cross

Plasma at the Front

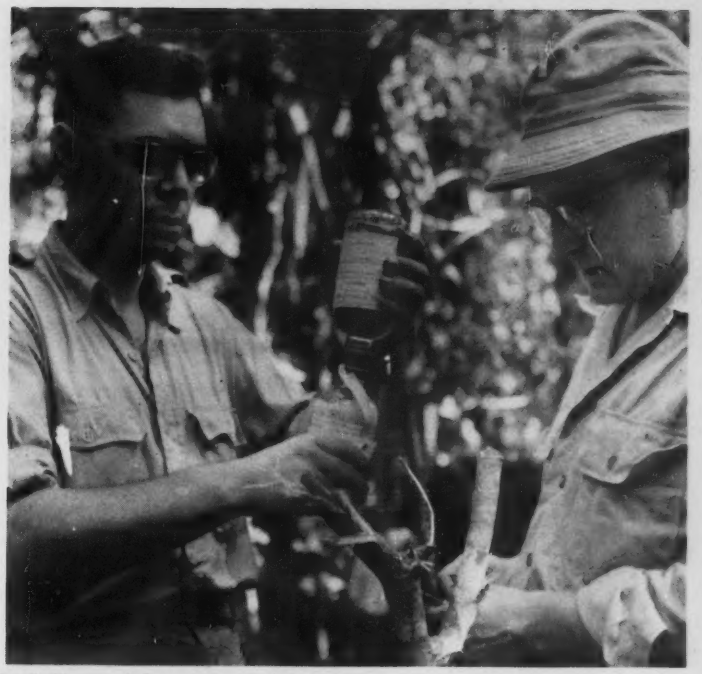
Another shot of plasma being prepared for a transfusion at the front.

Photo, Harry Poague, American Red Cross Correspondent

Plasma at the Front

Plasma being given to a wounded fighter behind the Buna front.

Photo, Harry Poague, American Red Cross Correspondent



Red Cross Plasma at the Front

Here the plasma is being prepared for a transfusion to a wounded fighter in an evacuation hospital just behind the front lines at Buna. Medical Corps men constantly express appreciation for the plasma which is saving the lives of our fighting men daily. The Army and Navy have requested three times the amount of blood given in 1942 to be given this year, 1943.

Photo, Harry Poague, American Red Cross Correspondent

Haven of Hope

Pain-ridden, numb with shock, these Marines know the relief that medical science has brought to the rigors of war. Flown from the Solomons to a Navy medical ship, they are being given Red Cross blood plasma transfusions — literally new life. Thanks to the blood donations of fellow-Americans, most of them will live to tell the story.

Photo, U. S. Navy

THE WELL-BRED SHORT CIRCUIT

By RICHARD B. MARSTEN, 6–45
Publications Editor, The Tech Engineering News

ONE of the most annoying troublemakers encountered in engineering practice — the short circuit — has recently been put to work. The device incorporating its use, known as the *amplidyne*, is quite simple in principle and in structure, and has already demonstrated its value in industry. The amplidyne has been used effectively for controlling machine speeds, limiting loads, holding tension, regulating currents and voltages, and many other labor-saving processes. It is more efficient than other apparatus and machinery currently used for the same purposes because it gives high amplification easily; it responds completely and almost instantaneously to even the weakest electric signals; circuits involving it are much simpler than they would be otherwise; and it can be used directly with either a-c or d-c equipment. A very important feature of its performance is stability. Because the characteristics of the amplidyne are built into its system, it needs only one adjustment — when new — to give a constant high performance throughout its working life.

Basically, the amplidyne is no more than an externally driven d-c generator. Its use of a short circuit and compensating winding, however, make it sensitive to the smallest electric signals, and produce an instantaneous, accurate, and powerful response to them.

Imagine a conventional, externally driven d-c generator of 10 kw. power, connected to a resistance load of one ohm (Fig. 1). If an excitation power of about 100 watts is supplied to the field coil an excitation flux is induced, of sufficient strength to produce full-load voltage, and therefore full-load current, in the armature conductors and thence through the load. But the load current creates an armature flux as it flows through the armature conductors, and this flux, which is of the same order of magnitude as the excitation flux, does no useful work. At the same time the excitation power has become too large for accurate control devices. Two problems arise from this system: first, how to reduce the excitation power to a point where small, fast-response control devices can be used, and still have this power produce full-load output, and second, how to utilize the armature flux.

If a smaller field coil is used in the generator, it becomes convenient to reduce the excitation power, and consequently load voltage and current, to a very small fraction of their original values. This reduction of the excitation power places it within the range where its supply and handling by accurate control devices is practical, but full-load working power is not maintained, nor is the original magnitude of either the excitation flux or the armature flux. How can full-load working power (and therefore flux) be regained, while the low excitation power is preserved?

A short circuit across the brushes of the armature conductors is part of the answer. This short circuit necessitates disconnecting the load, but it restores armature current and flux to their original magnitudes, at the same time preserving the low excitation power and flux. The whole setup can now be controlled by this power, which is extremely small. The armature

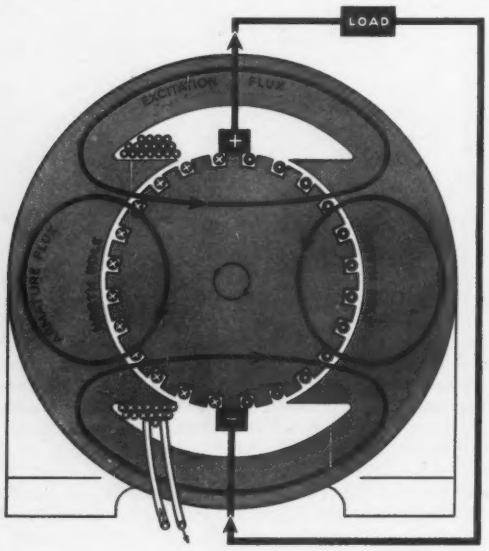


Figure 1

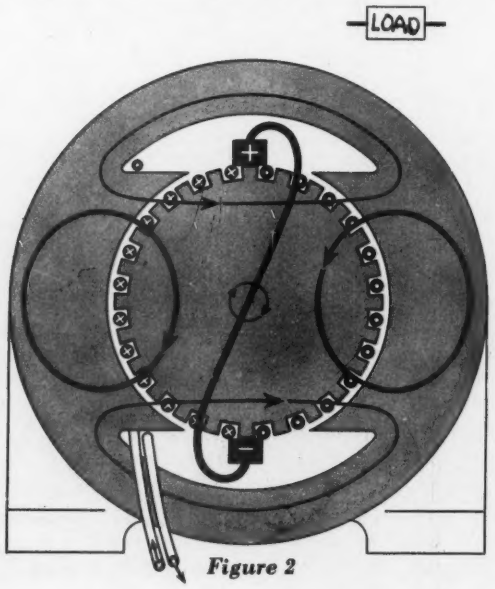
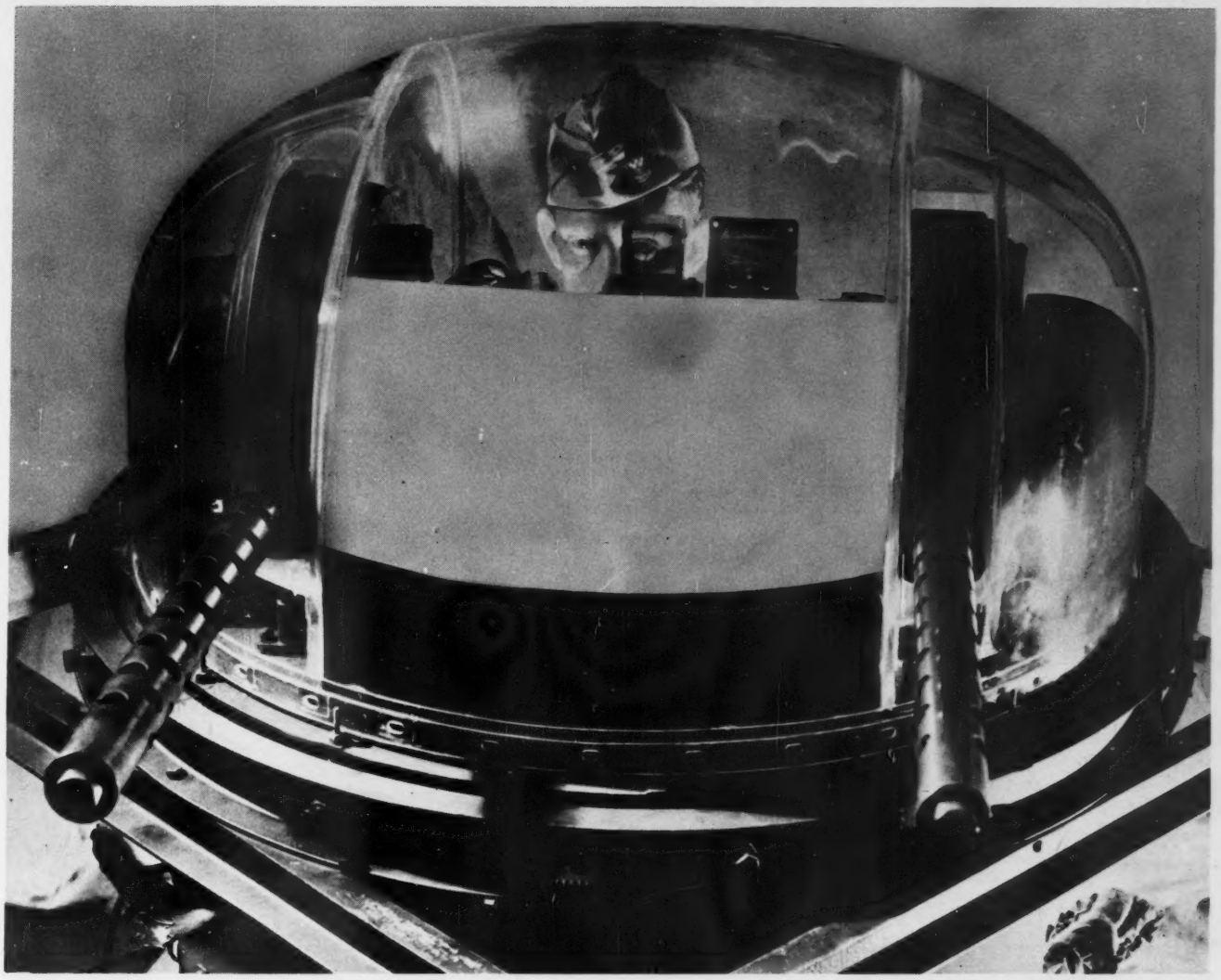


Figure 2



Protection for America's Bombers

Turrets like this make American heavy bombers the best protected planes on earth. Equipped with GE amplidyne control, it can be maneuvered with great ease against wind or ice resistance encountered in flight. (Behind the screen is hidden the secret of the turret mechanism. It has been whited out in compliance with government regulations.)

flux, however, is still idle, and must be put to work (Fig. 2).

A brush is therefore placed in the center of each armature flux loop, just as the original generator brushes are placed in the centers of the loops of excitation flux, and these brushes are now connected to the resistance load — one directly, and the other through a compensating field winding. Since the armature flux is full size, it induces a full-load voltage between the brushes, and since this voltage must pass through the load, full-load current is established, and also full-load working power (Fig. 3). The effect of the compensating winding is to neutralize any attempt of the load current to set up its own armature flux in opposition to the excitation, or control, flux.

This is an amplidyne. If the excitation current is doubled, the short-circuit current, and therefore armature flux, load voltage, and load current, are all doubled, and the total power output is increased four times, going from the original 10 kw. to 40 kw. To obtain this amplification with ordinary generators, two would be required — one excited by the control signal, and the other by the output of the first. This would produce a cumulative delay in responding to the control signal. The amplidyne, however, is a two-in-one generator, which uses the same structure twice by means of armature excitation, making response almost instantaneous. It provides two-stage amplification faster than a conventional single stage.

So far, the amplidyne has been discussed in the

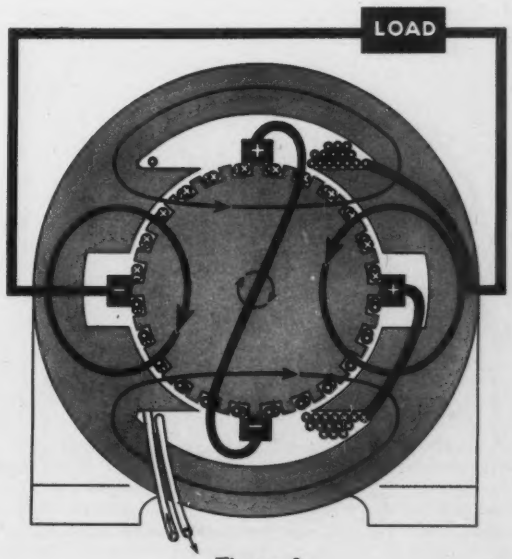


Figure 3

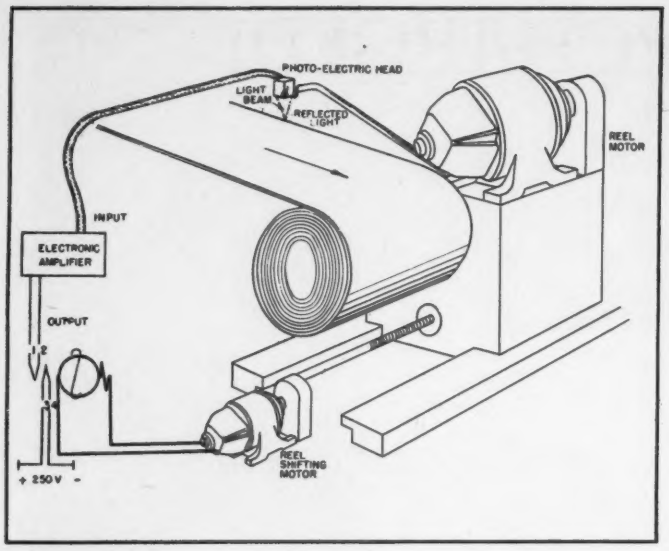


Figure 4

Light variation in photoelectric device is electronically amplified and supplied to voltage field (1-2) where it is compared to reference field (3-4). Any difference causes the amplidyne to operate the reel-shift motor.

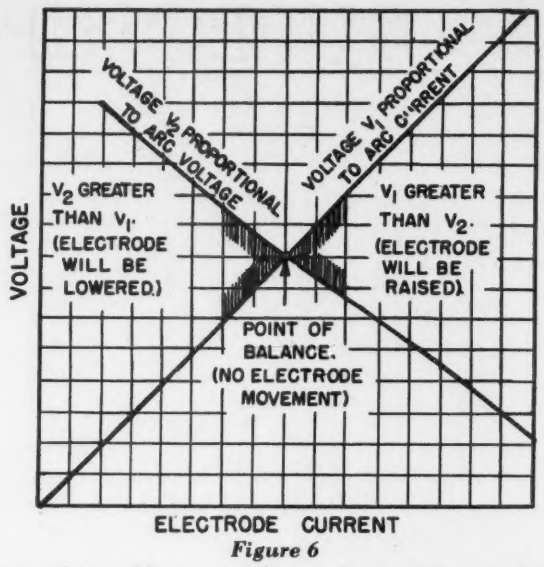

VOLTAGE V2 PROPORTIONAL TO ARC VOLTAGE
VOLTAGE V1 PROPORTIONAL TO ARC CURRENT
V2 GREATER THAN V1. (ELECTRODE WILL BE LOWERED.)
V1 GREATER THAN V2. (ELECTRODE WILL BE RAISED.)
POINT OF BALANCE. (NO ELECTRODE MOVEMENT)
VOLTAGE
ELECTRODE CURRENT

Figure 6

Curves of arc voltage and electrode current as balanced in the amplidyne field

light of its application as a single control device. However, it has been demonstrated that the amplidyne responds equally as well to several control fields independently excited by signal devices as it does to a single field. The character of the control field windings makes it possible for the amplidyne to be constructed with a multiple control field capable of producing an instantaneous response to a large number of independent signals. The use of the amplidyne with a multiple control field greatly reduces the number and size of control devices necessary for desired performance.

The small size and high sensitivity of the amplidyne fields offer many advantages not found in conventional control devices. Because of this compactness and sensitivity, these fields are easily adjusted over a much wider range than can be covered by other control devices. This imparts considerable flexibility to any system using the amplidyne, and allows operating limitations to be changed quickly and easily whenever necessary. Also, the multiple control fields facilitate the use of a greater number of control functions, thus making automatic operation more efficient and steadier than it is with conventional control. The instantaneous response of the amplidyne to control signals, together with its high amplification factor and forcing action, makes machines give maximum efficiency even under extremely rapid changes in operating conditions, and it is because of its large amplification factor that a small field accurately controls the excitation of large power apparatus. Since these characteristics are built into its system, the performance of the amplidyne is maintained constant, and therefore one adjustment is sufficient to regulate its performance.

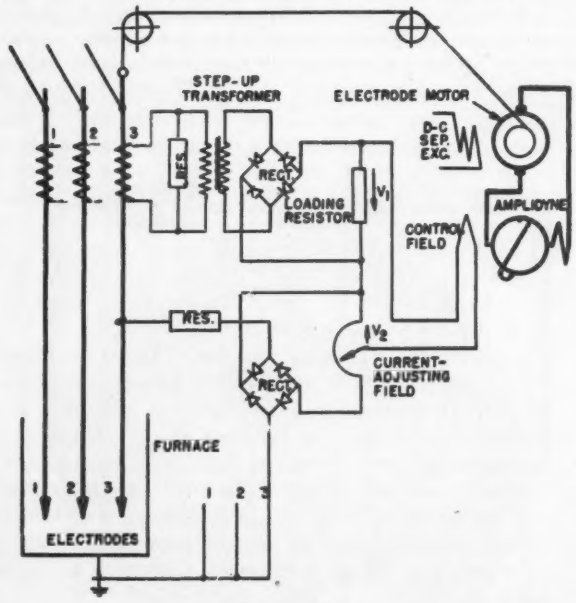


Figure 5

Electrode-current indication is stepped up to V_1 to balance the arc voltage, V_2, at the correct value of power in the arc. Any change in either creates unbalance, thus causing current to flow in the amplidyne control field. Power is thus supplied to the positioning motors to raise or lower the electrodes.

The amplidyne is represented in circuit diagrams by the symbol ( ), which graphically represents it as two generators compressed into one. The short-circuit ( ) and the control field ( ) represent the first stage, as described above, and the circle and compensating winding ( ) represent the second stage — the part that is connected to the load and does useful work. Since the control field excites the "works" of this machine, it is obvious from the symbol that the slightest variation in this field will produce an instant response in the amplidyne proper, and that the sensitivity of the amplidyne is largely dependent upon the sensitivity of this field.

Applications of the amplidyne are by no means limited, as explanations of a few different ones will show. Three of the simpler uses of this machine will be considered.

The amplidyne was instrumental in solving the problem of accurate positioning in motion — the positioning of any material running through a machine — for instance, alignment of a moving roll of paper in a paper-mill. With the use of side-register control, the amplidyne can hold an accuracy of 0.01 inch in controlling the position of the edge of the paper, and it can move the paper through the entire width of this positioning zone in one-hundredth of a second or less, while maintaining smooth, stable operation. This is accomplished with the aid of a photoelectric cell, set to watch the position of the edge of the paper. Reflected light striking the cell is converted into an electric

(*Continued on page 60*)

TURBOSUPERCHARGED!

By ARTHUR LINZ, JR., 2–46
Associate Editor, The Tech Engineering News

Pictures Courtesy General Electric Company

THE hardest hitting group of planes in the Allied Air Armada, which is today smashing at the Axis the world over, are American turbosupercharged bombers and fighters. Over a year ago, the Under-Secretary of War, Robert P. Patterson, said that the Boeing B-17 Flying Fortress (shown in flight above) and the Consolidated B-24 Liberator were "the fastest high altitude, long range bombers now flying. . . . Their performance on all battle fronts has been impressive." *That* was a year ago. Later improvements have made them even better. Added bomb loads and an increased range have made them the scourge of the once Axis skies over Europe. And much of this has been made possible only through the use of the turbosupercharger. So far as is known, Germany, which has developed good two-stage geared superchargers, has not produced a turbosupercharger. This, plus the famous Norden bombsight, gives the United Nations unquestioned superiority of the air in the higher altitudes.

During the early months of the war Germany exploited her command of the air to terrorize all Europe, but thanks to new developments, the trend has now turned the other way. Because of America's tremendous volume of plane production, the performance abilities of our planes, and the daring and superior training of the pilots who fly them, the newspaper headlines now herald the exploits of Allied flyers.

Most of today's air war is carried on in the stratosphere, where planes can operate only with the aid of a supercharger. The history of the turbosupercharger's development is a tribute to American inventive genius.

The gasoline engine is very similar to the human body in at least one respect: it requires oxygen to run. When a person goes aloft in a plane the weight of oxygen that he can draw into his body with a single breath decreases because of the rarefication of the atmosphere, and he cannot exert himself so much as at sea-level. A similar situation prevails with the internal combustion engine. At high altitudes each stroke of the piston draws in less oxygen than at sea-level, so less fuel can be burned and the available power is considerably reduced. At 25,000 feet, for example, the power loss may be well over fifty per cent.

To obviate this difficulty, engineers have developed the turbosupercharger, a mechanism which compresses the rarefied air before it is fed to the engine. This turbosupercharger consists of two main elements, a turbine and a compressor, with their rotating elements mounted on a common shaft. The turbine wheel works on the general principle of the old-fashioned water-wheel or windmill, and is driven by the exhaust gases from the engine, which are fed to it through a system of piping and nozzles.

The principle of its operation is simplicity itself: the turbine drives the compressor, which, by virtue of its high-speed rotation, sucks in the air of the atmosphere and compresses it before feeding it to the carburetor of the engine. And there is a marvelous "compensating"

Dr. Sanford A. Moss of General Electric. Generally credited with being the "inventor" of the turbosupercharger and a pioneer in the supercharger field.

factor to the operation of the turbosupercharger which is not to be found in any other supercharger. As the plane goes higher, the "back-pressure" on the gas-exit side of the turbine wheel decreases with decreasing atmospheric pressure, the wheel runs faster, drives the compressor faster, and thus gives the needed greater step-up of the pressure between the atmosphere and the carburetor.

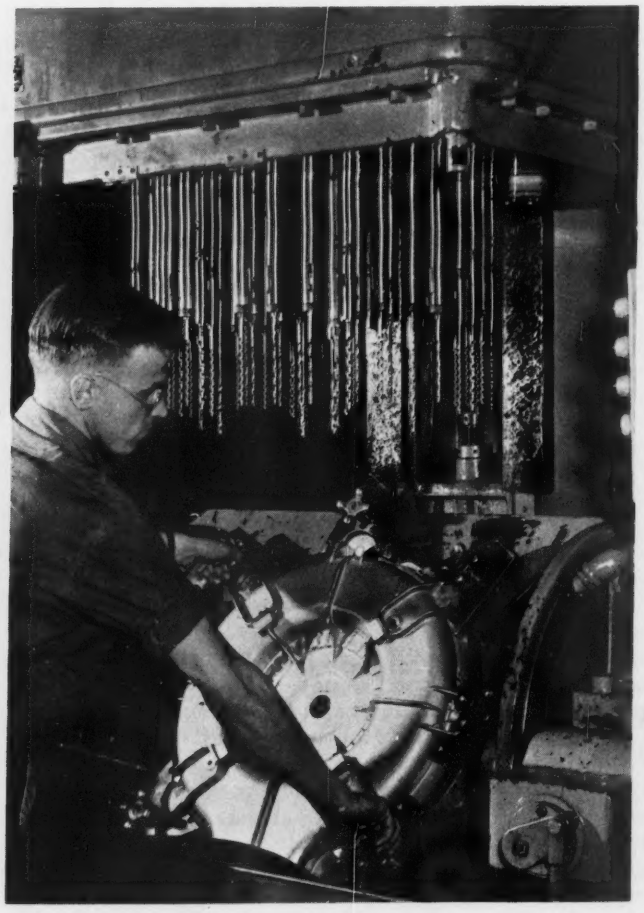
Simple though the principle is, the problems in the design of the turbosupercharger were far from simple. Not the least of these was finding a metal which could be used in the turbine blades. As the exhaust gases leave the airplane engine at super-hurricane speeds and are destructive to ferrous metals, dozens of problems in metallurgy and design engineering had to be overcome before the device would operate successfully. It runs at more than 24,000 revolutions a minute, with the turbine red hot at about 1500 degrees Fahrenheit, and the compressor only a few inches away handling atmospheric temperatures as low as 75 degrees below zero. The details of the solution of this problem are still zealously guarded secrets, for with that information the enemy could probably produce turbosuperchargers with the same devastating results against us that they are producing against him.

Years were required to solve all these problems and the story of the turbosupercharger dates back to the first World War, when the idea was suggested in France and was brought to the attention in the United States of Dr. William F. Durand, Chairman of the National Advisory Committee for Aeronautics.

Dr. Durand recalled that years earlier one of his

(*Continued on page 64*)

From 67 degrees below zero to 1500 degrees above in a space of 18 inches. Supercharger impeller, in General Electric's Fort Wayne, Indiana plant, being secured to shaft at left, is exposed to temperatures as low as 67 degrees below zero when fighting aircraft soar in the stratosphere, while the turbine wheel, on the right end of the same shaft and but 18 inches away, is driven by the hot exhaust gases from the airplane engine, at a temperature of 1500 degrees above zero. Both revolve at speeds of more than 20,000 revolutions per minute with exceptionally close clearances.



Fifty-two holes with one drilling. Fifty-two holes are drilled in turbosupercharger casing in a single operation on this multiple-spindle drill at General Electric's Fort Wayne Works.

The completed turbosupercharger. Shown with the device is a General Electric engineer, attached to the U. S. Army, one of several who tour the world battle fronts to insure technical advice as to the care and upkeep of the important part of the high-flying airplane.

Supercharger impellers. Hundreds of these are produced daily at General Electric's Fort Wayne, Indiana, plant for the superchargers that go into our fighting aircraft.

Close-up of assembly line. As the turbosuperchargers start down the line at General Electric's Fort Wayne, Indiana, plant, parts to be added are contained in the drawers of the box on which each supercharger is mounted. The larger parts to be added "flow" along another movable rack to the rear of each worker.

ELECTRONICS

By JOHN S. HOWKINS, JR., 6–45
Personnel Manager, The Tech Engineering News

ELECTRONICS is a much used and much abused term. In the strict sense of the word, "electronics" is that which has to do with the action of electrons. Such a general definition includes heat, light, magnetism, and electricity. The control of the electron has been the job of the electrical industry since its inception. When the radio came along with the vacuum tube in which electrons are not confined inside copper wires but pass out into confined space, we had a new and more restricted definition of electronics.

The electron tube is of surprisingly simple construction considering the uses to which it is put. It has been found that certain metals, among them tungsten, emit electrons when hot, while no cold bodies do except the radioactive elements. The electron tube consists fundamentally of a vacuum tube containing a filament, usually of tungsten, which is heated to incandescence, and a metal plate (Figure 1). When there is a high potential difference across the tube, the filament being the cathode, the electrons emitted find themselves in the vicinity of a strong positive charge and are immediately attracted to the plate, thus causing the tube to conduct a current. When the polarity is reversed, no current flows because the cold plate emits no electrons. This tube is known as a rectifier.

All electron tubes are not vacuum tubes. It has been found that an electron travelling at high velocity colliding with a gas molecule is able to release electrons from that molecule. Electrons thus released reinforce those travelling to the plate, while the remaining positive ions are attracted to the cathode and are neutralized. An electron tube partially filled with a gas therefore has a much higher current carrying capacity than a vacuum tube.

A direct current is essential to many important industries, but there are certain difficulties which arise from its transmission. The heat loss in a current carrying conductor is directly proportional to the square of the current it carries. To conserve power, therefore, as low a current as possible is necessary. However, the voltage of a direct current dynamo cannot be stepped up. (It is conventional to speak of voltage, rather than of current, being stepped up or down, and, since power is the product of voltage and current, a step up in voltage corresponds to a step down in current.) The principle of the transformer is that fluctuations of current in the primary winding produce a varying magnetic flux passing through the secondary, which induces a current in the secondary winding. A direct current does not produce a satisfactory varying flux and, therefore, cannot be used for transmission.

Since both the usefulness of a direct current and the transmission facilities of an alternating current are desired, means have been produced for transforming alternating current power into direct current power. The thyratron is a gas filled rectifier with a grid, or wire screen, between the electrodes (Figure 2). If the grid is positive with respect to the filament, it will retain some of the electrons passing through it, thereby decreasing the current flow through the tube. In industry the capabilities of a direct current are used in such things as welding, driving power, electrolysis, and

Figure 1. The diode, or common rectifier tube

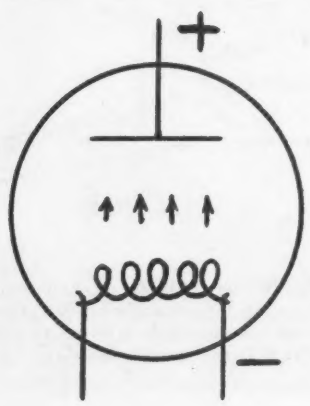
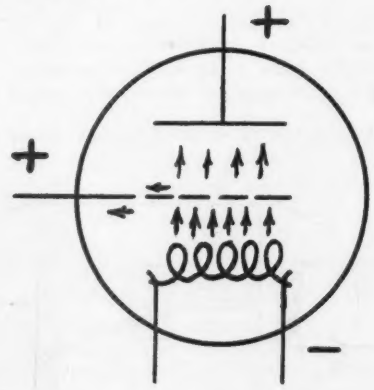


Figure 2. The triode



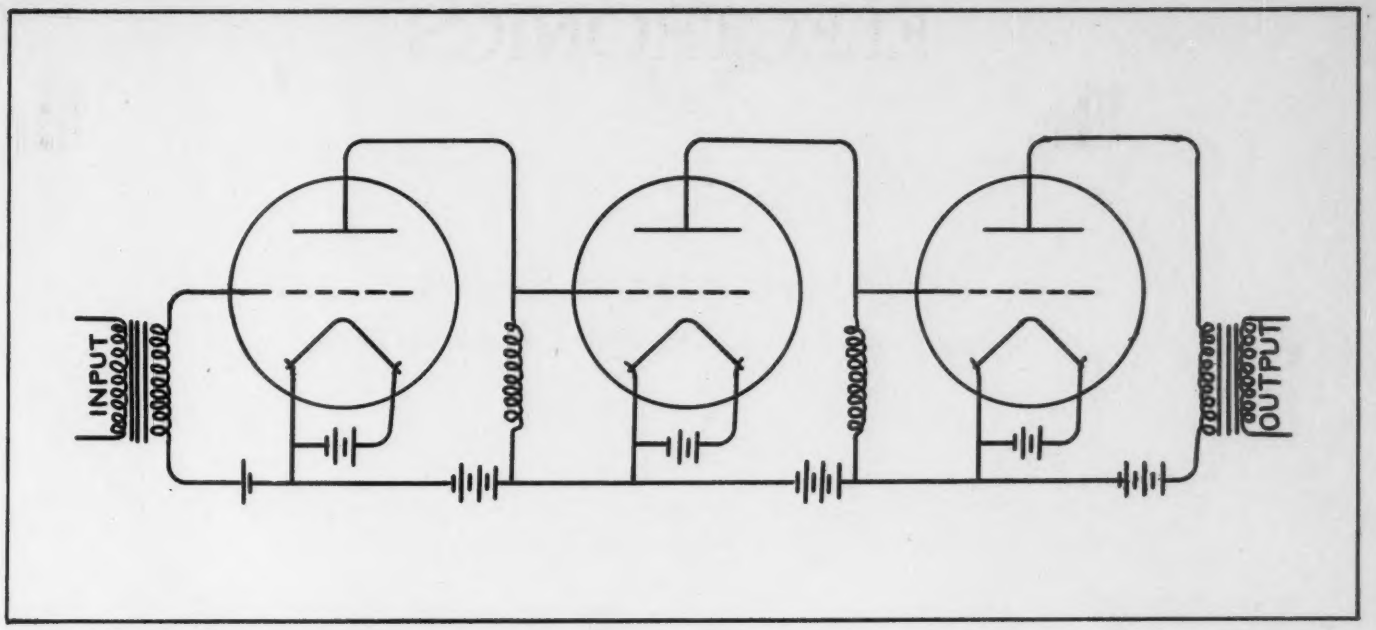


Figure 3. Fundamentals of the amplifier

the like. A direct current motor runs with much less vibration than does an alternating current motor and affords stepless acceleration, both of which properties are demanded by industry. The thyratron is designed to transform the current and to afford simple current control by varying the potential of the grid.

The radio tube is like the thyratron tube with the exception that it is smaller and often contains a vacuum. Very small variations of potential, such as those generated in the antenna, can be greatly amplified in the tube, for small variations of the potential of the grid produce proportionally large changes in the number of electrons attracted to the plate and thus in the current through the tube. In this way the infinitesimally small currents that flow from antenna to ground can be amplified by relaying them through a battery of tubes (Figure 3).

Electron experiments performed some time ago presented the fact that a stream of electrons is deflected by the presence of a magnetic field (Figure 4). This fact is the basis of television. The "electron gun" that produces the stream consists of a filament and a metal shield containing a small hole. The shield is between the filament and the field and is positive with respect to the filament, but negative with respect to the plate. If the magnetic field can be varied, and it can if an electromagnet is used, the electron path, and thus its point of termination on the plate, can be varied, and with a two component field, a spread can be formed (Figure 5). If the potential of the shield with respect to the filament is varied, the number of electrons striking the plate can be changed inversely proportionally. The leads from the two field magnets, the shield, and the cathode, are connected to three radio receivers, one to control the brightness of the spot instantaneously formed on the screen, and the other two to control the two field magnets. In this way the beam is swung back and forth about fifteen times a second to form a picture on the plate, which is transluscent and sensitized to indicate the position and intensity of the electron stream.

The oscilloscope, used for determining wave forms for varying potentials, is constructed almost exactly like the television cathode ray tube. The major difference between the two is that the oscilloscope tube, instead of shifting the electron beam with a magnetic field, does so with an electric field. The beam passes through two pairs of parallel plates in succession, the pairs being perpendicular to each other. Across one pair is kept a potential varying with constant period which sweeps the beam across the screen in a straight line. Across the other pair is placed the potential

(*Continued on page 68*)

Figure 4. Deflection of an electron beam in a magnetic field

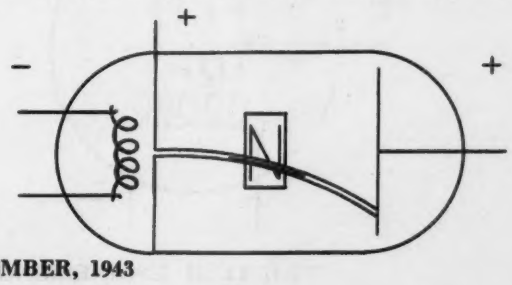
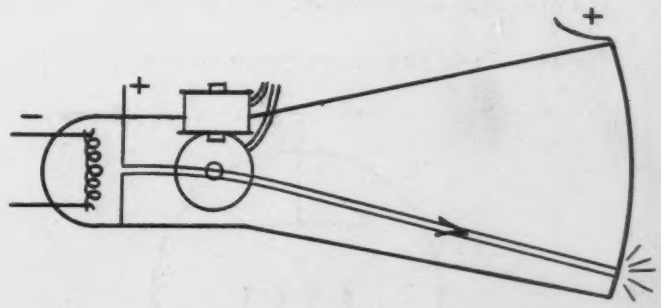


Figure 5. Television cathode ray tube



***ON THE FOLLOWING PAGES:** Low pressure spindle with all-welded rotor, in process of construction, for one of the largest tandem-compound steam turbines ever built. This impulse reaction type turbine is rated at 147,000 kw, 1800 rpm.*

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WE DISAPPROVE . . . .

One of the most unfair blows that American science has received in the present war recently came out of Washington: the Kilgore Science Mobilization Bill. This bill, introduced by Senator Harley M. Kilgore of West Virginia, is in effect an indictment of our wartime scientific effort for unefficient and inadequate support of our war effort coupled with a proposal to bring science under government control. As such all those who have any interest in science should become acquainted with the proposal, for, if passed, its effects would be far-reaching and pronounced.

The suggestions and intimations of Bill S702, as it is listed in the Congressional Record, cover an extremely wide range. The first section, in which Senator Kilgore explains the purposes of and reasons for the bill, is probably more striking than any other. In it he states that there is a "lack of adequate appraisal" and an "improvident and unplanned training, development, and use of scientific personnel, resources, and facilities in relation to the national need." This statement is clearly illustrated by such "improvident" centers of training and development as M. I. T., Cal Tech, and the many concerns carrying on private government research such as General Electric, Bell Telephone, Westinghouse, and Arthur D. Little. Later on in this section a complaint is raised over the unfortunate "absence of an effective Federal organization to promote and coördinate in the national interest scientific and technical developments," the "uncoördinated state of information," and the "unassembled personnel." Upon visiting any library the author would probably be amazed to find that the *Industrial Arts Index*, a monthly publication the size of any one of our most voluminous magazines, is barely able to *index* the large amount of material published on the findings, doings, and proposals of science. As for the American Chemical Society (34,200 members), the American Association for the Advancement of Science (25,000 members), the American Men of Science (28,000 members), and the 500,000 men registered with the National Roster of Scientific and Specialized Personnel, these "unplanned and improvident" organizations were apparently overlooked. As was the Office of Science Research and Development, established by President Roosevelt at the beginning of the war, which has carried out $188,000,000 worth of non-profit research from which has resulted $2,000,000,000 worth of war material orders to date.

What Senator Kilgore proposes to substitute for this "inadequate" system is even more interesting. Under his bill there is to be set up an "Office of Scientific and Technical Mobilization" consisting of a "National Science and Technical Board" under an "Administrator." This board would have blanket powers over the nation's scientific and research facilities and personnel, including the right to requisition any materials, patents, information, or discoveries it deems necessary, to say nothing of having complete control over the drafting of scientific personnel during wartime. An enlightening piece of addenda to this bill is the fact that nowhere in it is any stipulation that it is only a wartime measure.

The reaction to this legislation has been violent. The A. A. A. S., the A. C. S., and the Electrochemical Society have all registered vehement votes of disapproval. However, there have been some interesting arguments for and proponents of the bill. Vice-President Wallace, in a speech entitled "Rules for the Century of the Common Man," endorsed centralization and coördination of all scientific activities, even if it meant government control. Yet back in 1938 the National Resources Committee, including Frederic A. Delano, Harold L. Ickes, and Henry A. Wallace, stated that it wished to encourage "decentralized research, furthered only by the existing interagency councils of scientific coördination."

All those who have any interest in scientific progress should register some kind of protest to their Congressmen or Senators, for government control of scientific research and personnel is unpleasant to all of us. Moreover, it would hinder the prosecution of the war to suddenly "coördinate" all war effort and then subject it to domination by some outside agency. Above all, no one can deny that science has been meeting its wartime obligations steadily and without complaint. Under positive government control of all science the danger of destroying initiative and self-assertion, so dear to us in the United States, is high, as one could witness in the pre-war totalitarian states.

For the preservation of a free and unrestricted science, any such measure as Bill S702 should be fought and defeated immediately. C. B. B.

WHAT'S SPIRAL-4?

Closely following our advancing forces rolls a truck, with Signal Corps men paying out telephone cable. There are no stops for splicing—for the ends of the quarter-mile lengths are fitted with weather-proof connectors that snap together.

This is Spiral-4—a new type of rubber-covered field cable which helps the Signal Corps establish communications *quickly*. When connected to suitable terminal carrier equipment, this Western Electric product provides three telephone and four telegraph circuits in a single cable—about the thickness of a fat pencil—containing four spiralling wires.

Another important feature of Spiral-4 is that an enemy tapping this cable—when *carrier channels only* are being utilized—would get nothing but a jumble of sounds.

This new carrier type communications system is but one of many war products on which Western Electric engineers are working now—developing special manufacturing equipment and methods. This field of Engineering for manufacture offers a wide range of opportunity to men who are interested in the technical problems of production.

BUY WAR BONDS REGULARLY—ALL YOU CAN!

Western Electric

IN PEACE...SOURCE OF SUPPLY FOR THE BELL SYSTEM.
IN WAR...ARSENAL OF COMMUNICATIONS EQUIPMENT.

ALUMNUS OF THE MONTH

Last month in this space, THE TECH ENGINEERING NEWS *presented a biography of Dr. William David Coolidge. Although Dr. Coolidge did not graduate until 1896, having been held back a year by illness, he is usually regarded as one of the "big three" of the Class of '95.*

Gerard Swope, T.E.N.'s "Alumnus" for November, is a second member of that triumvirate. It is our hope that next month THE TECH ENGINEERING NEWS *will be able to feature Mr. Alfred P. Sloan, thus completing the group. — ED.*

GERARD SWOPE, '95

It is men such as Gerard Swope who give the lie to the timeworn accusation that M. I. T. produces men who are "engineers but not human beings." Few men in his generation have been more willing to devote their entire energy and ability to the "welfare of his fellow men . . . constructive public service in the field of social civic, and humanitarian effort."

The quotation is from the citation which accompanied the Hoover Medal, presented to Mr. Swope earlier this year for his "preëminent services [to] the well being of mankind [and] the development of a richer and more enduring civilization." The qualities which brought this honor to Mr. Swope have manifested themselves in everything he has done. And in all his activities, as business leader, economist or engineer his thinking has been of a fundamental and analytic quality inherent in the trained engineer.

It has been said that one of the greatest contributions which can be made to society today is to see that great industrial units are efficiently and conservatively managed, while at the same time providing leadership to all industry in the broader humanitarian relationships of management and men. During the long period of Mr. Swope's presidency of the General Electric Company (1922–1940, and since 1942) he has kept that aim constantly in mind. Through periods of expansion and depression he has instituted reforms in his company and suggested programs for industry as a whole which were designed to meet with the changed conditions which he felt sure lay ahead.

Among these, two are perhaps most notable. The first was the unemployment insurance plan, which, while helpful to company employees directly, was of even greater value in that it tremendously influenced thinking on the subject throughout the United States, both in industrial and governmental circles. In the five and a half years in which this plan was in operation before National Social Security made it unnecessary, over $7,000,000 was provided for use in this plan — about half by the employees and half by the General Electric Company. During this same period nearly $4,000,000 was distributed in benefit payments and over $1,000,000 was loaned to employees. It was the successful operation of private industry plans such as the one developed by Mr. Swope which were in a large part responsible for the final adoption of the Social Security Act. For his work in this field he was made a member of the Advisory Council on Social Security.

Probably the high point of Mr. Swope's genius for evolving solutions to the problems of industry was reached when he proposed the so-called "Swope Plan" for the "stabilization of industry." The five basic principles underlying his proposals were: Regularity and continuity of employment by the stabilization of industry with unemployment insurance to fall back upon; Leadership by organized industry, with which responsibility rests; Standardized forms of reports to stockholders to give to the owners of a business the proper information regarding the business; Coördination of production and consumption on a broader and more intelligent basis for the particular benefit of the wage earners; Promotion of initiative and enterprise for the protection of the public.

For this proposal and other social services Mr. Swope was awarded the gold medal of the National Academy of Social Science for 1932.

Other honors have been heaped upon Mr. Swope. France made him a Chevalier of the Legion of Honor. He holds honorary doctorates from five American universities. Even our enemies, the Japanese, recognized his talents in bestowing upon him the Order of the Rising Sun. His greatest recognition came after the last World War, when the United States Government awarded him the Distinguished Service Medal for his work with General Goethals in the purchase, storage and traffic organization of the general staff of the United States Army. The citation read in part:

"It was due to his foresight, ability, energy and loyal coöperation, that the procurement program for the great Army of 1918 was successfully planned, and he assisted materially in carrying it into effect, thereby contributing directly to the success of the military program."

Foremost among Mr. Swope's many other civilian activities is his position as a life member of the Corporation of the Massachusetts Institute of Technology and member of the Institute's Executive Committee.

If past experience is any basis for judgment, we may look confidently for important developments in city housing programs, for Mr. Swope is the chairman of the New York City Housing Authority, and his public service record will doubtless be enhanced by his work in this field during the expected post-war boom in large low-cost housing developments.

The Rubber Plant

with roots two miles deep!

THE MAKING OF synthetic rubber involves among other things the exact control of gas mixtures of great complexity. Formerly the analysis of some gases required several days of painstaking laboratory work, and in some cases a complete analysis was impossible.

Westinghouse scientists—working in close collaboration with engineers of leading oil and chemical companies—have perfected an electronic "chemist" which is an important addition to the present methods of analysis.

With the improved technique and apparatus now available, the time required for accurately making some of these analyses has been reduced *to an hour or less!*

An amazing electronic device . . . known as the* mass spectrometer *. . . not only improves the accuracy of the synthetic rubber process, but frees hundreds of skilled chemists from tedious but important production testing in these vital plants.

The mass spectrometer analyzes gases by sorting the molecules—according to their mass—in (roughly) the same way that a cream separator sorts out the cream from whole milk.

Let's say we want to analyze a simple gas mixture containing *one part* of oxygen and 10,000 parts of nitrogen. Here's how the mass spectrometer accomplishes this incredible feat:

First, the gas sample is bombarded with electrons. This *ionizes* the nitrogen and oxygen molecules, giving them electrical charges of their own.

These ions are then drawn by electrical force into a curved vacuum tube. Here, ions of different molecular weights whizz around *different curved paths*—depending upon their reaction to a powerful electromagnet surrounding the tube.

The heavier oxygen ions follow a straighter path than the lighter nitrogen ions and are directed through a tiny exit slit onto a plate where they give up their electrical charge. The amount of this charge, amplified and recorded by sensitive electrical instruments, is an extremely accurate measure of the *quantity of oxygen* in the gas mixture.

The starting voltage is then changed to allow the nitrogen ions to pass through the same exit slit—thus measuring the *quantity of nitrogen.* This same principle applies to the analysis of complex hydrocarbon mixtures.

The development of the mass spectrometer . . . for the quick, accurate analysis of butadiene . . . is a typical example of the way Westinghouse "know how" in electronics is tackling the wartime problems of industry in an effort to speed victory.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.

Westinghouse

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FIGHTING BLOOD

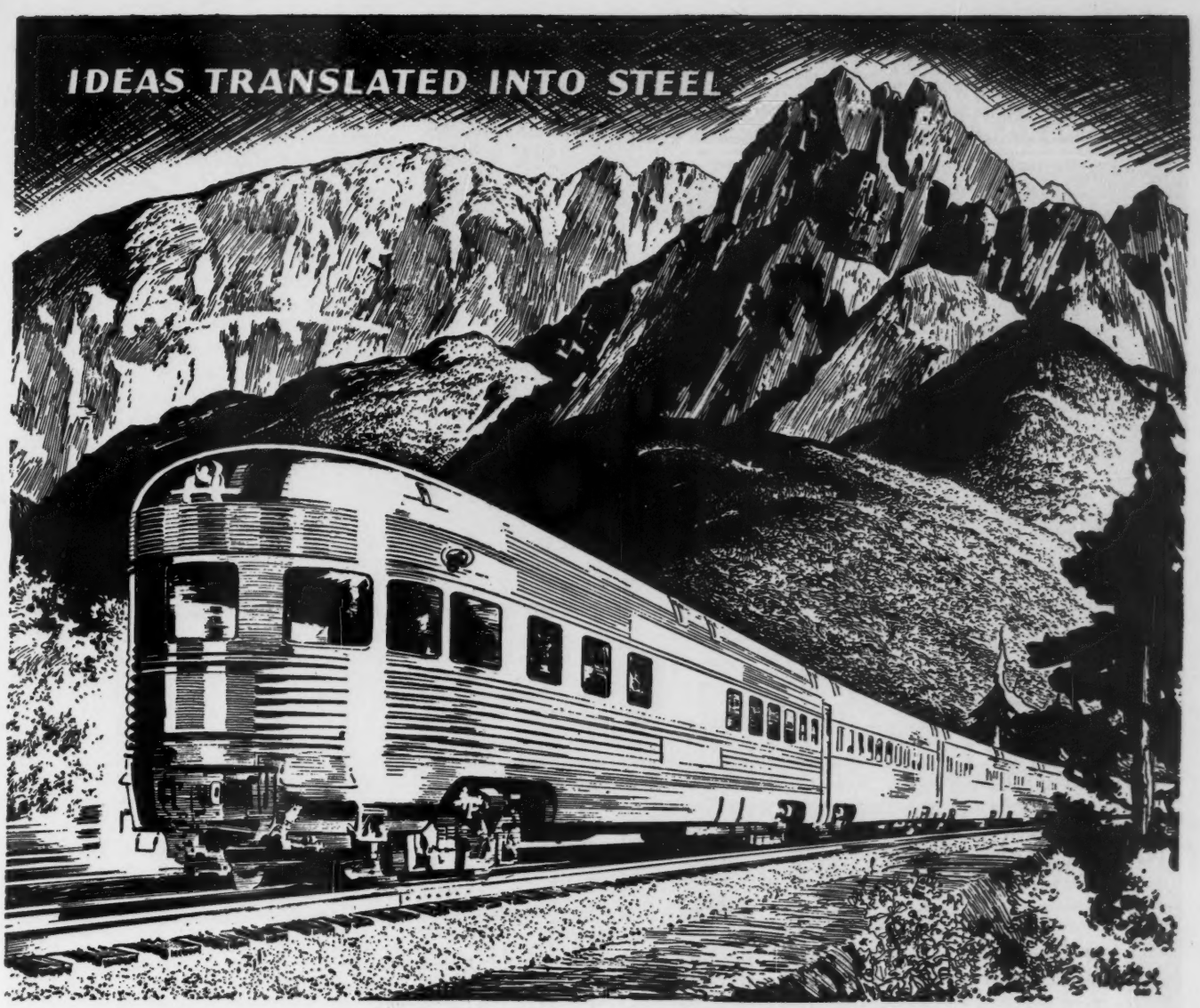
(*Continued from page 39*)

modern high-explosive shells and warfare arise from a loss of blood and the resulting fatal drop in blood pressure. Until the new mobile blood plasma unit, shown in the accompanying pictures, was developed, blood had to be replaced by actual transfusions from live donors or from carefully stored whole blood. As a result, only the most serious cases received the transfusions they needed. But now merely mixing the plasma with the accompanying bottle of distilled water supplies 1000 cc. of blood substitute, enough to mean the difference between life and death for a dying victim.

Countless stories come from all fronts telling of the miraculous cures effected by plasma. Take the case of Lieutenant Arthur McQuaid of the Navy Chaplain Corps. He was aboard a cruiser on the way to intercept a Japanese convoy when the cruiser was sunk and Lieutenant McQuaid badly burned on his face, arms and legs. His case seemed hopeless, so the next day he was lowered over the side of the ship to die in a base hospital on Tulagi. But the medical officers must have misjudged the value of plasma, for after receiving three transfusions he rallied from the shock and today is recovering the use of his arms and legs.

Or to quote Corporal Anthony Casamento of the Marines, "I was shot up all over, and I was bleeding for about an hour and a half. I was shot in the chest, shoulder, arms, through the neck and ear, and my fingers were broken by hand grenades. . . . I crawled up a hill and some Marines found me and took me in (and) I was given a quart of plasma. . . . I have seen plasma save an awful lot of lives. It certainly saved me."

All the plasma for this vital need must come from individually donated blood. Totally aside from the humanitarian principle involved in giving blood to save a man's life (for *every* pint you give will either save a man's life or help to save it) every casualty which has been rescued from death can fight again and contribute that much more towards winning the war, sooner. Every qualified citizen of the United States should give blood as often as he can and give it now when it is needed the most. For remember, although it's only *your blood*, it's *his life*.



Yes, that is a train, a modern, stainless steel, lightweight train. But more than that, it is the product of ideas.

To the railroad man with lines at the ticket windows and armies to move, ideas are measured by performance. Trains like this have helped the railways to roll up a magnificent record in serving the war needs of our country. They have been able to do the impossible because they began to build soundly for better transportation long before war impended.

Our whole American war machine is rolling into full power by reason of ideas developed by a free industry. Planes, tanks, naval vessels, anti-aircraft—all ideas, translated into steel.

That train you see is a Budd-built train—designed by Budd engineers, constructed by Budd skilled workmen. It embodies ideas of weight-saving which require less power and fuel; ideas of streamlining which increase speed; ideas of smooth-riding comfort; ideas of sturdy stainless steel construction which provide safety and uninterrupted service.

None can be built now. The steel is needed for war and the Budd plants, filled with men trained to ideas and steel, are working one hundred percent on Army and Navy orders.

But ideas live. And skill is not forgotten. The gleaming stainless steel trains you see today are a brilliant promise for the future.

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*REG. U. S. PAT. OFF.

THE WELL-BRED SHORT CIRCUIT

(*Continued from page 46*)

signal, which is amplified in an electronic amplifier and passed into the amplidyne control field. The signal from the control field is compared to a reference field (Fig. 4), and any discrepancy between fields excites the amplidyne, which then supplies power to the reel-shifting motor, thus moving the paper back into position.

Another application of the amplidyne is that of power control for positioning objects at rest. The amplidyne can be used to regulate power wherever electrical characteristics are adjusted by mechanical means, such as in an electric-arc furnace. Used as an arc furnace control, the amplidyne maintains uniform heat, automatically adjusts individual electrodes, and provides power for smooth positioning, whether up or down. In this case the amplidyne is used on an a-c

(*Continued on page 62*)

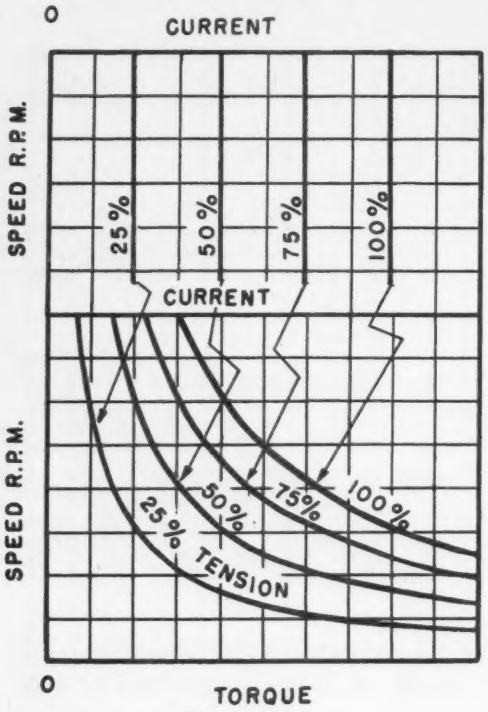
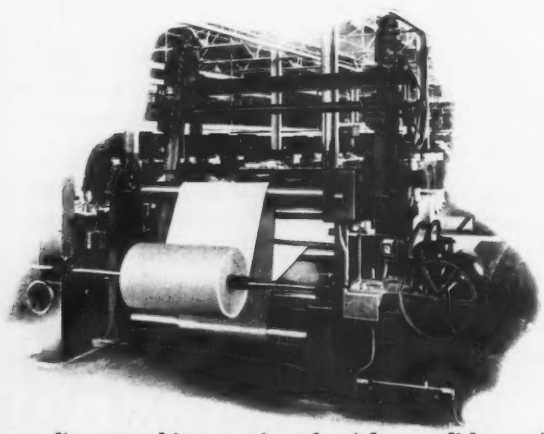
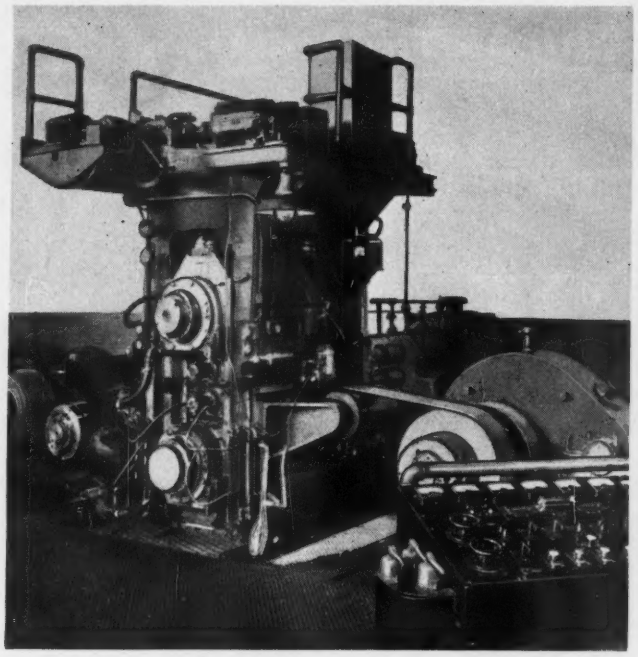


Figure 7

Upper chart shows constant current (or tension) held by the amplidyne over a wide speed range. Lower chart shows torque-speed curve obtained over the same speed range.



Paper-reeling machine equipped with amplidyne side-registered control. Weft-straightening and other similar continuous processes use the amplidyne profitably.



Amplidyne-controlled reel motor on cold-strip mill Current control is extensively used to obtain constant tension, load limit, load balance, and the like in such applications as paper winders, reels, strip grinders and skip hoists.

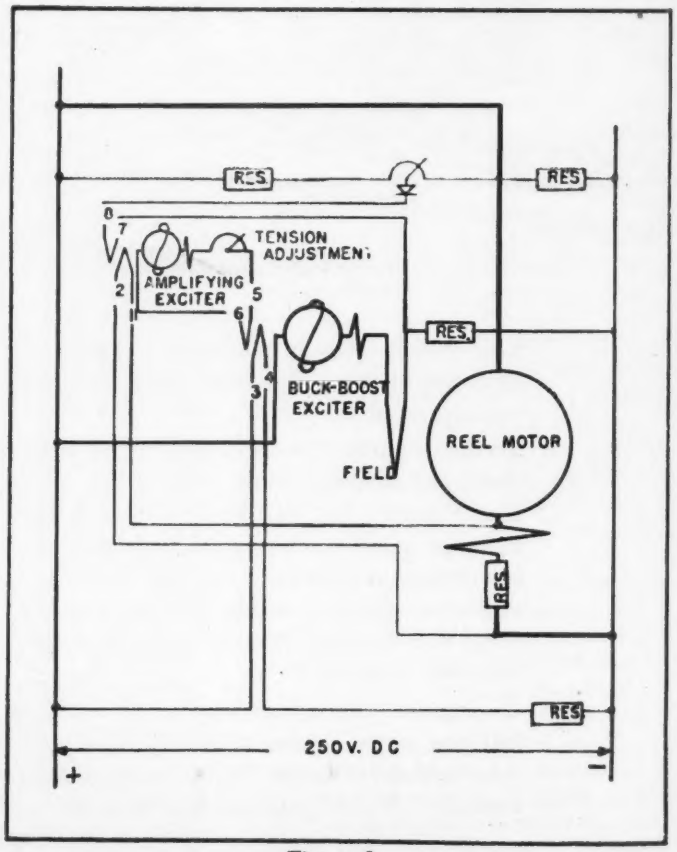
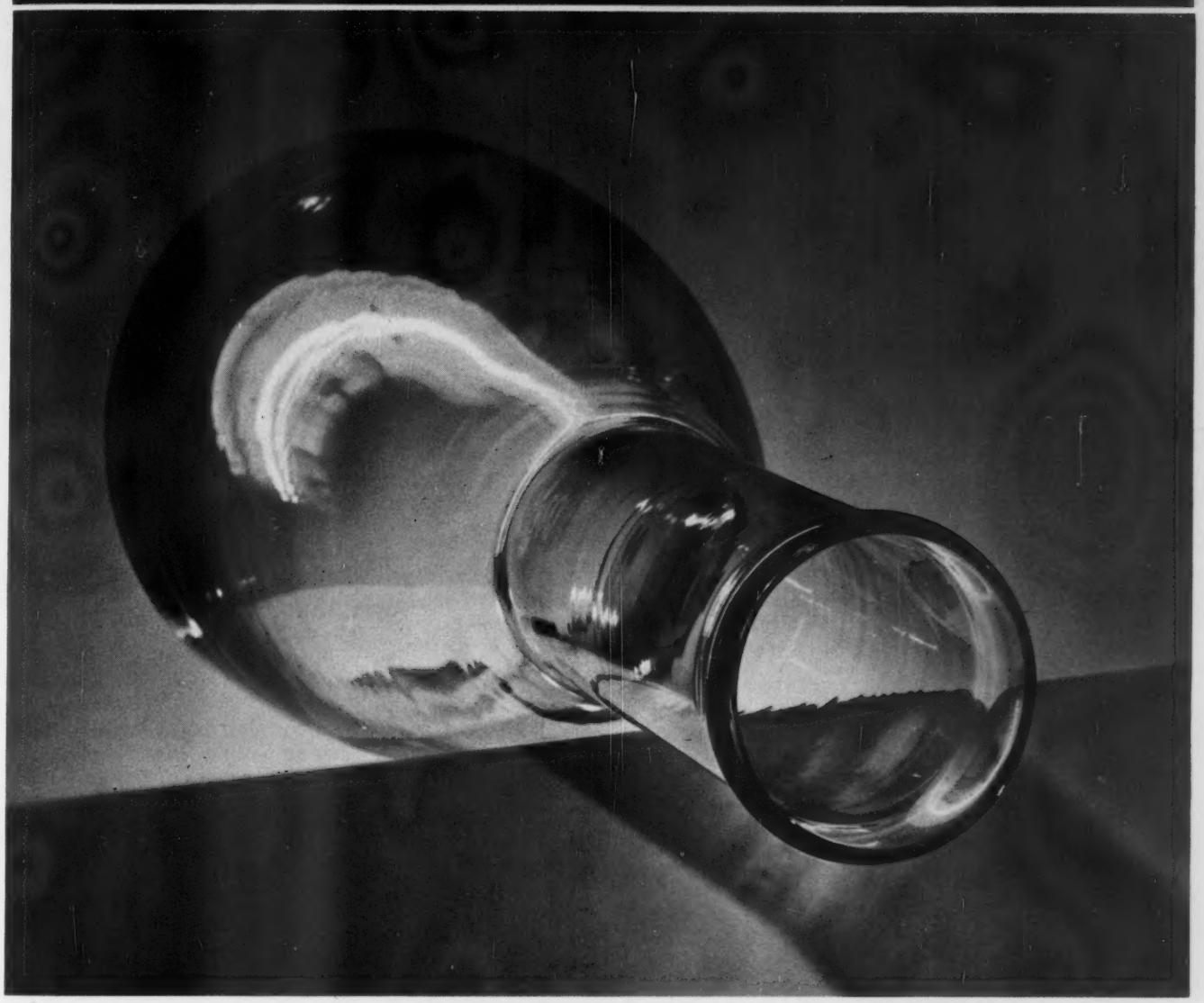


Figure 8

Reference field (3-4) tends to increase torque of the reel motor and, consequently, tension. The IR drop in the reel motor commutating field excites the amplidyne, supplying field (5-6) which opposes reference field (3-4). A balance between fields (5-6) and (3-4) is quickly reached. A limit field (7-8), normally inactive, acts to strengthen the motor field whenever its current drops below a minimum value.

Submarine hunt in the Chemung Valley . . .



NO, it isn't a gun or a new style bomb. It's all we can show you of a special glass tube that is part of our secret submarine listening apparatus.

The same kind of tubes are used in listening devices that can pick up the menacing hum of an enemy plane miles away. And they're made out of special glass, to exacting requirements, by skilled Corning workmen in the peaceful Chemung Valley in Southern New York State.

Did we say "peaceful"? That isn't exactly correct. No subs actually prowl the Chemung, but there's plenty of warlike activity going on at Corning Glass Works, just as in every glassworks in the whole United States.

For Corning, like other glassmakers, was ready to turn its skill and experience to our country's use before the smoke had cleared at Pearl Harbor. For example, since World War I, Corning has developed medical and chemical glassware that frees this nation from dependence on foreign imports. This material is now flowing in a steady stream to industry, hospitals, and laboratories.

Hundreds of other items are made by Corning to aid the war effort. Optical glass, insulators for planes and tanks and ships, heavy glass parts for the manufacture of explosives, even glass precision gauges (ring, plug and others). Many of these jobs represent new uses for glass, where glass replaces metals because it is strong, resistant to wear and corrosion, and fairly plentiful. After the war many of these uses will stay, and new ones will be added because glass is a material of endless possibilities. And then, as now, Corning will be the center of American glass research.

In your own future as an engineer, *keep your eye on glass!* Corning Glass Works, Corning, New York.

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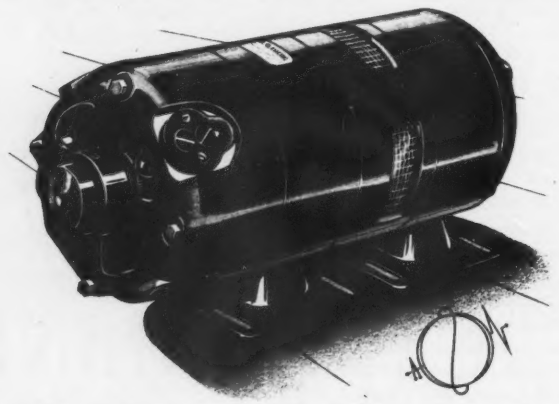

This is the "well-bred short circuit" after having graduated from finishing school

WELL-BRED SHORT CIRCUIT

(*Continued from page 60*)

circuit, as a generator to supply power to the electrodes' positioning motors. In the reference and control fields, rectified current and voltage values are opposed, variation between the two fields exciting the amplidyne, which supplies power to appropriate motors to move electrodes in the proper direction (see Figs. 5 and 6).

One of the commonest uses of the amplidyne is its application to current control. In this process it holds current in a motor or generator circuit within close limits, and remains unaffected by speed, voltage, or load changes. The advantages derived from its use in this manner are of major importance: machinery can be operated for long periods at maximum efficiency with no danger of overload or mechanical failure, constant tension can be held in a continuous process, and maximum acceleration and deceleration rates can be obtained. In particular, the use of the amplidyne with a reel motor is typical. Using two amplidynes in the circuit, the motor can be operated over a wide speed range with constant current and tension assured. Precise control is maintained by using the reel motor current to excite one amplidyne, which then excites the second, and this in turn, through a "buck-boost" connection, supplies the motor field (see Figs. 7 and 8).

Not content, however, with making the amplidyne do its part on the home front, engineers have taken it to war, where it has been put to work in a number of military applications, such as maneuvering and firing heavy weapons, and controlling searchlights to aid anti-aircraft operations. Its use in airplane gun turrets makes it possible for one man to maneuver, sight, and fire guns accurately in the wind resistance encountered in a plane flying at top speed—a feat that would otherwise be impossible.

In the process of producing cold rolled strip steel, use of the amplidyne boosted production forty per cent above the previous maximum. Attached to the boring mill, it made possible automatic positioning accurate to about one part in five thousand. In electrolytic tinplating it cut rejections more than fifty per cent. Wherever it is used, this new, well-behaved, coöperative short-circuit is increasing production, efficiency, and accuracy, as well as improving quality and conserving manpower and materials.

Its role in the post-war industry will be even greater.

The Synthetic Age ushers in a **New Era** for the Coke Oven

Nearly half a million new combinations of the molecules have been developed since the synthetic age came in. Millions of new ones are possible. Nearly every time a synthetic material has been developed it has meant a drastic reduction in the price of the material and that has meant an ever-widening market, in the familiar pattern of mass-production.

In the last year for which official figures are available, almost half of the synthetic organic chemicals produced in America came from coal tar sources.

Vast new opportunities stretch away before the modern coke oven and before the people who work with it.

Koppers is the largest builder of coke ovens. It is one of the principal producers and distillers of tar from which many of the chemical wonders stem. It is one of the first designers and builders of recovery plants from which come materials for use in plastics, synthetic rubber, paints, varnishes, dyes, solvents, motor fuel, disinfectants, medicines, flavors, explosives. One of Koppers affiliates is the nation's largest independent producer of bituminous coal.
—Koppers Company and Affiliates, Pittsburgh, Pa.

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TURBOSUPERCHARGED!

(*Continued from page 48*)

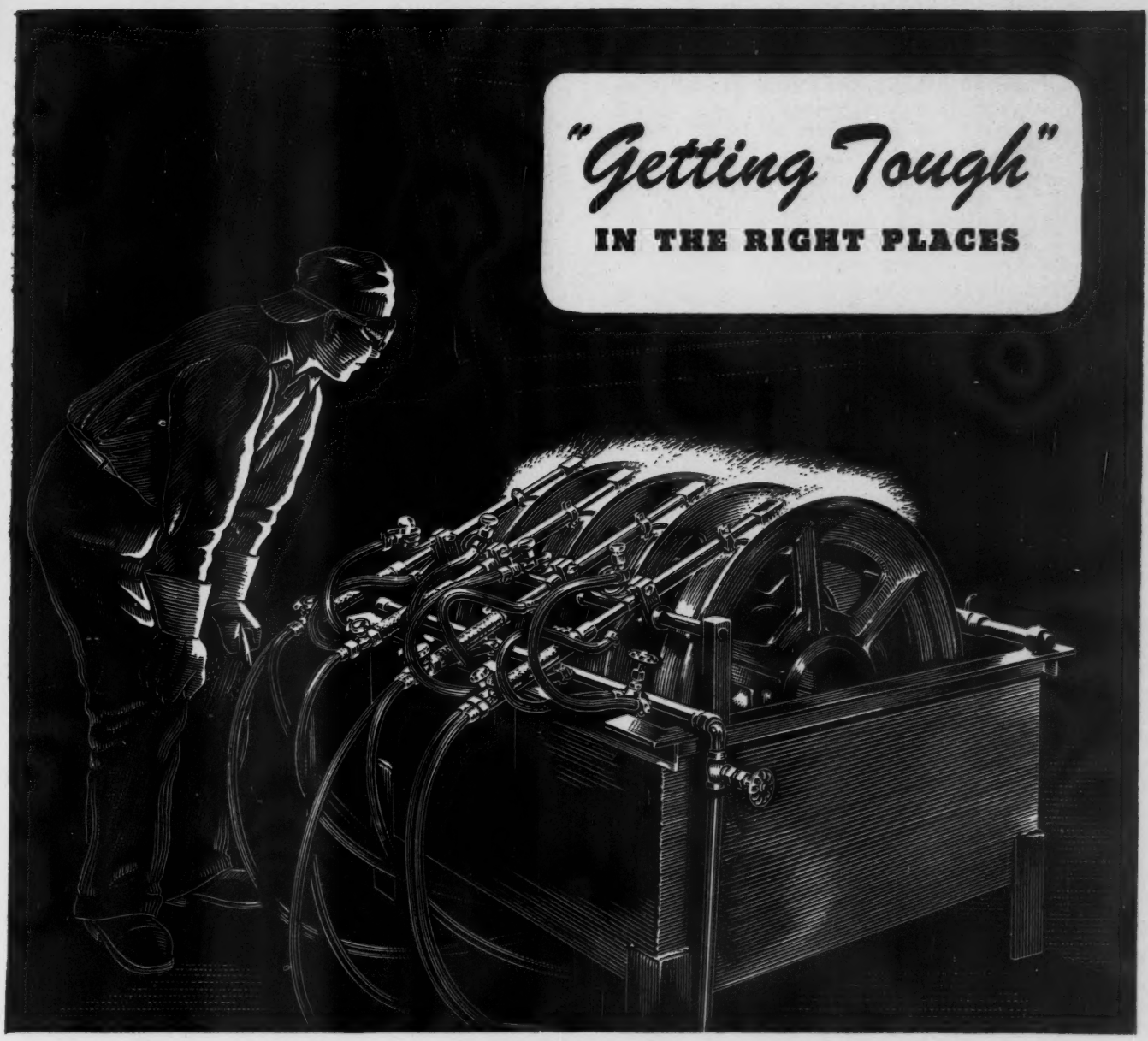
former colleagues on the Cornell University faculty, Dr. Sanford A. Moss, had kept the engineering school filled with strange smokes and had written a thesis on the gas turbine. Since then Dr. Moss had developed a number of centrifugal compressors. As the turbosupercharger is essentially a combination of a gas turbine and a compressor, Dr. Durand turned the problem over to Dr. Moss, who succeeded where the Frenchmen had failed.

Colonel Howard C. Marmon, a member of the famous Indianapolis motor car family, who was then a commander of McCook (now Wright) Field at Dayton, Ohio, authorized construction of a working model as

(*Continued on page 66*)

Ready for war. Completed turbosupercharger undergoing final inspection

Stitching with an electric needle. Electronically controlled resistance welding machine being used to spot-weld supercharger parts



CABLE sheaves for mining, drilling, and hoisting equipment are subjected to unusually heavy strains these war days. To stand up under continuous operation, the sheaves must combine hardness at the wearing surfaces with toughness in the spokes and hubs — contradictory properties not usually possible in a one-piece metal part.

How could these two conflicting metal characteristics be incorporated in the sheaves, without sacrificing either necessary quality?

Oxyacetylene flame-hardening provided the answer. Now the cable grooves, which are most exposed to wear, are given a hard, wear-resistant skin by flame hardening, while the remainder of the sheave retains the required shock-resistance that is already present in the parent metal.

Thanks to the localized protection afforded by this modern preventive treatment, the life-expectancy of the sheaves has been greatly extended, and another threatening operating problem has been nipped in the bud.

Many other equally successful techniques have been developed by Air Reduction service engineers for the application of oxyacetylene flame and electric arc processes to individual manufacturing needs.

If you want to keep posted on some recent developments of oxyacetylene flame and arc processes, write for a free copy of the illustrated booklet "Airco in the News." Please address requests to Air Reduction, Room 1656, 60 East 42nd Street, New York.

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TURBOSUPERCHARGED!

(*Continued from page 64*)

soon as he saw Dr. Moss' plans. After ground tests there Dr. Moss took a Liberty motor equipped with a turbosupercharger to the top of Pike's Peak in September, 1918.

Without the turbosupercharger the engine which had given 350 horsepower at ground level in Dayton produced only 230 horsepower on the 14,109 foot Colorado peak. With the supercharger the engine actually produced 356 horsepower on the mountain top!

The Armistice halted most World War research, but work on the turbosupercharger continued. Mechanical advances made successful the gear-driven supercharger around 1926. In this type, the compressor is driven from the shaft of the combustion engine through a speed increase in gearing. It was satisfactory up to about 15,000 feet for most purposes, and by 1929 three-fourths of America's airplanes had geared superchargers in engines redesigned by manufacturers in accordance with the ideas of Dr. Moss.

During the decade of the 1930's substantial progress was made in the field of turbosuperchargers, so that just prior to the outbreak of the war in Europe in 1939 these superchargers were actually in production in America, although the production was being carried out on a rather small scale by a staff of skilled workmen at the General Electric plant in Schenectady. With the advent of armed conflict, however, the demand for the pieces increased phenomenally, so that today they are being mass produced in a manner typical of large scale American industry.

Victory "garden" of superchargers. Each piece in this victory garden means better performance at high altitudes for our fighting aircraft. These are the outside casings of airplane turbosuperchargers undergoing inspection.

Airplane turbosuperchargers in production. As the superchargers are moved down this long line, each girl worker adds a part or does a particular operation. When they reach the end of the movable track, shown in the foreground, the turbosuperchargers are completely assembled and ready for final inspection.

Stepping Up... and Keeping Up the STEEL CUTTING PRODUCTION of the United Nations

WITH the outbreak of war in 1939, the Allied Nations—abruptly cut off from Germany as a principal source of supply for carbides—diverted the full flood of their carbide demands to the United States.

Fortunately, American industry had established—as far back as 1928—its own independent sources of supply. These American suppliers were ready to meet the emergency with a background of 10 years' experience in the development, manufacture and application of this urgently needed material. They had the skill, the equipment, and a generous margin of reserve capacity.

To the hard pressed Allied Nations—struggling to offset the tremendous output of a German war production long since tooled with carbide *by official decree*—went tons of American carbides in steadily increasing quantities. Foresight and preparedness enabled American carbide manufacturers to fill this urgent need and at the same time meet the pyramiding demands of domestic industries.

Today, you will find carbides a factor of vital importance in stepping up and keeping up the production of not only the United States but also such countries as England, Russia, Australia, Canada, China, India, Mexico and many others among the United Nations.

The full extent to which carbides are being used in the cause of victory is difficult to visualize. Carboloy Company production alone, for example, is at an annual rate 45 times greater than that of any pre-war year. Monthly production of carbides—formerly measured in pounds—can today be expressed in tons—many tons per month! Yet the average carbide tool contains but a fraction of an ounce of carbide at the cutting edge—and a single tool during its usable life machines hundreds of parts for the implements of war. Particularly important is the use of carbides for cutting steel—a major field of use for Carboloy tools. (More than 60% of the Carboloy Cemented Carbide produced today for machining purposes is for cutting steel.)

A high order of performance—so high as to have been once considered incredible—is now commonly expected, and obtained, with carbides. Such things as increases in output of 3 to 1, lengthened tool life of 10 to 1, finish cuts that eliminate arduous grinding, machining of former "non-machineable" alloys, reductions of 25%, 50%, 75% in machining costs—results such as these are every-day occurrences in war production today.

This widespread use of carbides in war, indicates a new era of production economy when normal commerce returns. Manufacturers who have converted to carbides to meet the present emergency will then have at their immediate disposal an economic weapon of unusual advantage in seeking world markets.

Carboloy Company, Inc., Detroit, Mich.

Authorized Distributors: Canadian General Electric Co., Ltd., Toronto.
Foreign Sales: International General Electric Co., Schenectady, N. Y.

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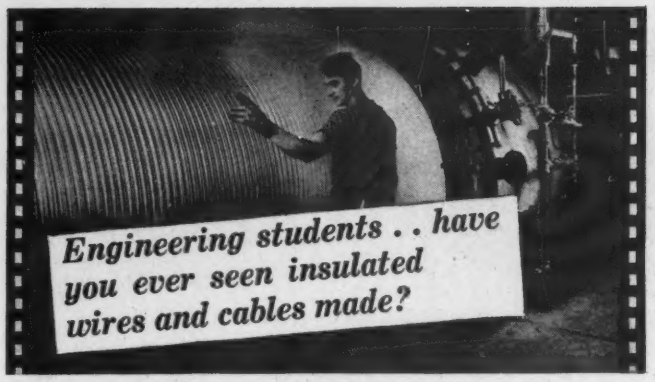

3303

It isn't necessary to visit a manufacturing plant to see how they are made and installed. The Okonite Company has motion pictures available, which we will be glad to furnish without charge at the request of any responsible organization. For instance:

"Rubber Insulated Cables" – Sound film, showing the manufacture of rubber insulated wires and cables from the raw material to the finished product. Narrator: Lowell Thomas. Projection time: 25 minutes. In 16 mm. and 35 mm. sizes.

You can arrange to have this picture for your next meeting by writing to:

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ELECTRONICS

(*Continued from page 51*)

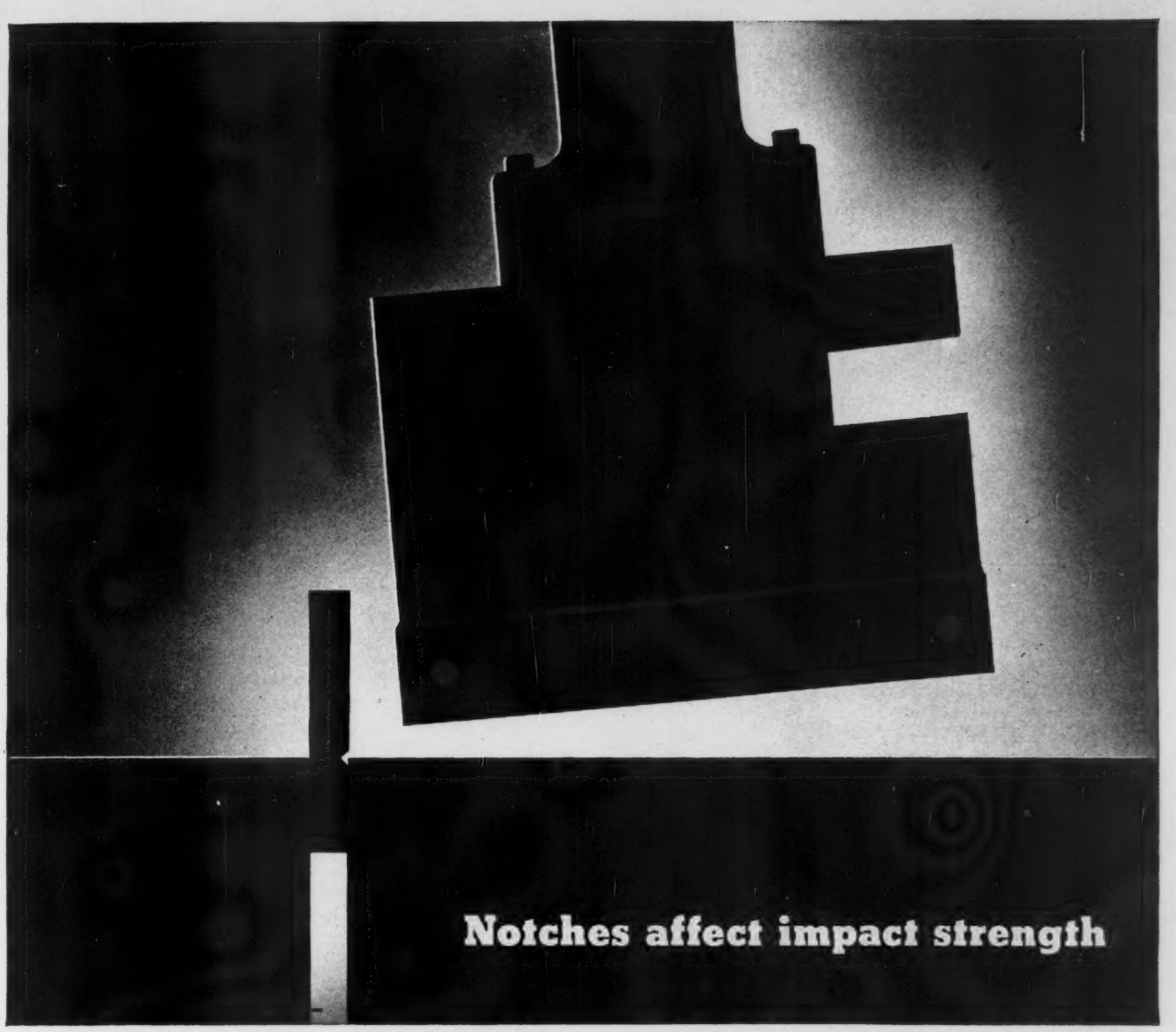
whose wave form is desired. The result is a wave on the screen. If the wave moves, the period of the original potential can be varied until a steady wave is obtained. The oscilloscope has numerous applications, such as determining the shape of sound waves and of even determining the torque generated by a motor from the twist of a calibrated shaft.

A very important application of electronics in the industrial as well as the medical fields is to X-ray. It has been found that the electrons that hit the plate in a tube emit a ray from the plate that ionizes the air through which it passes, can penetrate to certain depths in all materials, and affects photographic plates. The first of these properties is the reason for electrically shielding high power radio tubes from the rest of the circuit, for the air around them becomes conducting and may cause a serious current leak. X-rays, or cosmic rays, or Roentgen rays, as they have been called, have been produced, of very short wave length and by extremely high voltage, that will penetrate inches of hard steel. When using X-ray for inspection, two methods of observation are in use. A photographic plate can be exposed to the rays penetrating the specimen, or a fluoroscope, a translucent screen processed to show the presence and intensity of X-rays, can be used. Application is made of the X-ray in industry to the inspection for flaws, for a flaw will

(*Continued on page 70*)

Electronics, the amplidyne, and the turbosupercharger have combined to make this plane the safest and deadliest in the world.

General Electric photo



Information supplied by an Industrial Publication

The effect of fillet radius on the life of machine parts operating under alternating stress has been known for a long time. The knowledge has been put to good use in designing parts so as to avoid fatigue failures.

The effect of variation in the notch radius of Izod impact bars has shown the way towards the elimination of impact failures in filleted parts.

Two sets of standard size impact bars were machined from one heat of steel, both with a 45° notch. In one set the notch radius was 0.01 inch and in the other 0.05 inch. After quenching, and in some cases tempering, the bars with 0.05 inch radius consistently showed about 140% improvement in impact strength.

The practical application of these results, which consisted of increasing the existing fillet radius, has eliminated impact failures in a part where the problem had become serious.

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ELECTRONICS

(*Continued from page 68*)

show in the picture.* In the future machines can be made much lighter because the safety factor of X-ray tested pieces is much lower than the one that protected against unseen faults, and parts can be of lighter construction. For a number of years X-rays have been of importance in the practice of medicine in the location and inspection of foreign matter and broken bones in the human body.

A new and revolutionary use of electronics is the application of radio waves to heating. High frequency radio waves produce heat in dielectrics through which they pass by their action on the individual molecules of the dielectric. It used to take hours to bond plywood, and days to cure plastics by steam heating. This is because plywood and plastics are very poor heat conductors, especially thermoplastics, which are made for heat insulation, and it took a long time for the heat to penetrate all the way through. In induction heating the heat is produced in the material itself, it not being impermeable to radio waves. Now it takes only three to five minutes to bond plywood instead of that many hours. With induction heating faster and more uniform heat treatment of metals, annealing, brazing, welding, soldering, and tempering have been made possible by the reduction of time in some cases from two minutes to five seconds. In the tin industry steel sheets heated by induction are so much more evenly heated that two-thirds of the tin formerly employed is saved. In medicine the application of radio waves to heating is called diathermy, and it is used to treat internal parts of the body for bruises and sprains.

A relatively new and little known phase of electronics is carrier current relaying, in which a lightning strike or short circuit is detected before the excess current has time to do any appreciable damage. This application has found use in power transmission where a short circuit would otherwise cause considerable damage, not only to the line, but to the dynamos. Very sensitive electron tubes are capable of detecting the first slight backrush of current after a short circuit and of immediately relaying this information to circuit breakers which disconnect the damaged portion of the line. During a war when materials and labor are difficult to obtain, it is essential to protect what property we have, and this was electronics' answer to the problem.

The higher operating speeds of modern machine tools, the twenty-four hour day on which our plants are now running, and the increased number of machines per unit space have caused a great increase in the oil vapor content of the air in our factories. With this increased content has increased the fire hazard of the plant and the ill-health of the workmen. In order, therefore, to run an efficient plant, it is necessary to remove these particles from the air. An electronic application, the precipitron, has taken care of this. The precipitron is a device that draws the air through a strong electric field, where all impurities are electrically charged and then attracted to a plate of opposite polarity from the charging field, where the particles are neutralized and collected. In one plant as much as four gallons of oil were collected in one day, oil that would otherwise have settled on the machines, on the lights, in the machinists' eyes, and in their lungs.

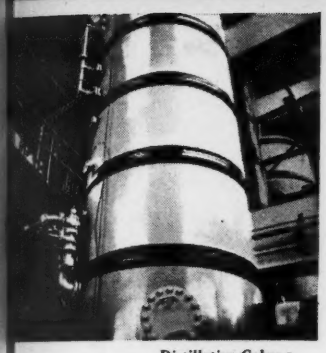
The electric eye we no doubt have all seen. There are two kinds of electric eyes, governed by two entirely different principles. One is that a few metals, notably selenium, are more electrically conducting in the presence of a light than in the dark. The electric eye using this principle is principally a piece of dielectric wrapped with two nonintersecting pieces of conducting wire. Over the face of this coil that is to be exposed to light is poured some of the molten activating metal. When this solidifies, the electric eye is complete. A potential difference is kept between the two wires so that, when a light shines on the activating metal, its resistence is lowered and a current flows which can be made to activate an electromagnetic relay. The other principle used by the electric eye is that a few metals, when illuminated, emit electrons much as does a filament. If one of these metals is made the cathode of an electron tube and a plate is introduced as anode, a current will flow through the tube when there is a potential difference across it and a light beam is shown on the cathode. This current, also, can be used to run an electromagnetic relay.

Many wonderful inventions will be uncovered after this war, many of which we have not heard much or anything about. For instance radar, which now locates the enemy whether he be in a tank, ship, submarine, or airplane, can be applied to making commercial flying much safer than it is today, to reducing the number of railroad accidents, and to warning ships of reefs. Once before electronics suffered a serious setback because the results of misapplied devices were misinterpreted and the progress of electronics was delayed. It is a science that has a great future, and that should not be interrupted.

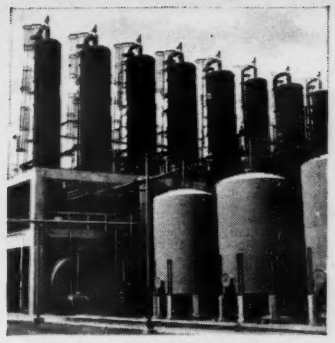
*Vol. XXV. No. 1, p. 5.

TEN YEARS' WORK IN TWO

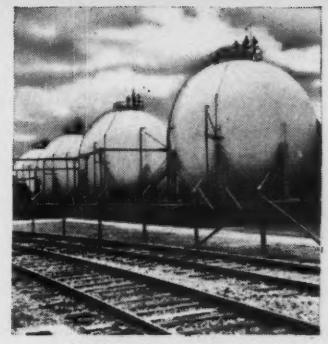
is the story behind Butadiene and Styrene for Synthetic Rubber



Distillation Column for Styrene



Where Distillation Columns separate and purify the Butadiene



Butadiene Storage Spheres

WE WISH YOU could see the first of the Government's large integrated synthetic rubber projects, complete at one location. What you see here is a night scene and some daytime views of the immense butadiene and styrene plants that CARBIDE AND CARBON CHEMICALS CORPORATION, a Unit of UCC, has designed and built at Institute, West Virginia, for the Government's Defense Plant Corporation and is operating for the Rubber Reserve Company.

Carbide and Carbon also has completed another butadiene plant at Louisville, Kentucky —and has released plans to Koppers United Company for a third butadiene plant near Pittsburgh, Pennsylvania.

Butadiene had never been manufactured in the United States in large quantities before the plants at Institute went into production. The task involved in providing the mass production facilities the Government asked for was an unusual one...but one that took full advantage of the experience and processes developed by Carbide and Carbon.

Generally, it requires seven to ten years for a company to take a process developed in the laboratory, put that process to test in a pilot plant, iron out production problems, design a full-size plant, and then actually build the plant and go into mass production.

By working at top speed for twenty months —Carbide and Carbon telescoped research, development, engineering, and construction work that would have taken 10 years in normal times. In this short time laboratory research was translated through chemical engineering into larger and more modern facilities for producing the chemicals for synthetic rubber than existed anywhere else in the world.

This achievement could never have been possible had it not been for the years of research and experimentation which, prior to the emergency, Carbide and Carbon had devoted to the production of synthetic—or man-made—chemicals of the organic series.

Business men, technicians, teachers, and others are invited to send for the book "Butadiene and Styrene for Buna S Synthetic Rubber from Grain Alcohol" which explains what these plants do, and what their place is in the Government's rubber program.

• • •

BUTADIENE, (bew-ta-dý-een). A highly volatile liquid which is the principal chemical in the manufacture of Buna synthetic rubbers.

STYRENE, (stý-reen). A liquid, like benzene, but having the property of reacting within itself to form a solid, clear, plastic mass. It is used as one of the principal ingredients of Buna S synthetic rubber.

BUY UNITED STATES WAR BONDS AND STAMPS

CONSTRUCTION RECORD AT INSTITUTE

June 25, 1941
Carbide and Carbon submits definite production estimates.

July 31, 1941
Design work starts on 10,000-ton-a-year butadiene unit.

Aug. 22, 1941
Government authorizes construction.

Dec. 7, 1941
Pearl Harbor

Dec. 15, 1941
Design "frozen" for 20,000-ton-a-year alcohol-to-butadiene plant.

March, 1942
Japanese occupy Malay Peninsula and Dutch East Indies; cut off about 90 per cent of U.S. natural rubber supply.

April, 1942
Construction on the first of four 20,000-ton-a-year butadiene units starts at Institute, W. Va.

July, 1942
Construction of 25,000-ton-a-year styrene plant starts.

Sept. 10, 1942
Rubber Survey (Baruch) Committee report accepted.

Jan. 29, 1943
First large-scale, alcohol-to-butadiene unit goes into operation two months ahead of schedule.

April 7, 1943
First styrene unit begins operation.

May 25, 1943
Fourth 20,000-ton-a-year butadiene unit begins operation at Institute plant.

August, 1943
Four 20,000-ton-a-year butadiene units producing at rate of 120,000 tons a year—50% over rated capacity.

UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N. Y.

Principal Products and Units in the United States

ALLOYS AND METALS
Electro Metallurgical Company
Haynes Stellite Company
United States Vanadium Corporation

CHEMICALS
Carbide and Carbon Chemicals Corporation

ELECTRODES, CARBONS & BATTERIES
National Carbon Company, Inc.

INDUSTRIAL GASES AND CARBIDE
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS: Bakelite Corporation • Plastics Division of Carbide and Carbon Chemicals Corporation

Massachusetts Institute of Technology
CAMBRIDGE, MASSACHUSETTS

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Architecture — City Planning — City Planning Practice

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Biology and Biological Engineering
  Options: Quantitative Biology
    Food Technology and Industrial Biology
Physical Biology
Chemistry
General Science
Geology
  Options: Geology
    Mineral Resources
Mathematics
  Options: Pure Mathematics
    Applied Mathematics
    Industrial Statistics
Physics
  Options: General Physics
    Applied Physics

SCHOOL OF ENGINEERING

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Building Engineering and Construction
  Options: Heavy Construction
    Light Construction
Business and Engineering Administration
  Options: Based on Physical Sciences
    Based on Chemical Sciences
Chemical Engineering
Chemical Engineering Practice
Civil Engineering
Electrical Engineering
  Options: Electric Power
    Illumination Engineering
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The duration of each of the above undergraduate Courses is four academic years, with the exception of Architecture, Physical Biology, and the co-operative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years, and City Planning Practice which covers a period of six years. In addition to the Bachelor's degree, the above five and six year Courses, with the exception of Architecture, lead also to the Master's degree.

Graduate study, leading to the Master's and Doctor's degrees, is offered in Ceramics, Meteorology, and in most of the above professional Courses.

A five year Course is offered which combines study in Engineering or Science, and Economics. This leads to the degree of Bachelor of Science in the professional field, and to the degree of Master of Science in Economics and Engineering or Economics and Natural Science.

For information about admission, communicate with the Director of Admissions.

The Catalogue for the academic year will be sent free on request.

and the services that go with them

TECO Design Service

Teco has available for distribution to architects and engineers complete data on all phases of timber design, including tables and charts on timber beams, columns, floors, connector loads, bolt loads, stresses, etc.

TECO Consulting Service

Teco maintains a staff of engineers to consult with architects and engineers on their design problems. Teco Connector distributors and fabricators in all parts of the country also render helpful services to architects and engineers.

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TIMBER ENGINEERING CO.

National Manufacturers of ***TECO*** *Timber Connectors and Tools*

WASHINGTON CHICAGO PORTLAND MINNEAPOLIS

G-E Campus News

RESEARCH AND ENGINEERING KEEP GENERAL ELECTRIC YEARS AHEAD

. . . PASS THE PLASTICS AMMUNITION

INSTRUCTION instead of destruction is the purpose of the new machine gun developed recently by the Edison General Electric Appliance Company. Designed to train soldiers, the new gun uses plastics bullets and compressed air instead of expensive bullets and gunpowder.

Operated by electricity, built to the actual size and appearance of the 50-calibre Browning machine gun, the new model will fire 600 rounds of plastics bullets per minute—the same rate as the Browning. But the new bullets cost less than a cent apiece (and can be used over and over), compared to the approximately 30-cent cost of each Browning bullet.

Amplified "explosions" of compressed air accustom the trainee to the sound of actual firing and tend to eliminate the jitters he might otherwise experience in his first combat.

TO THE RESCUE

BY the summer of '43 about the only new tail lights left were those on lightning bugs. The other kind were helping to save shipwrecked sailors who were often lost at night, because rescue parties couldn't see them.

When the Coast Guard asked G.E. for a tiny lamp that could be attached to rubber life suits, that would glow all night long, the Company supplied the lamps that they had been making for bicycle tail lights—small, rugged lamps that lasted a long time and used very little current.

These were enclosed with their tiny batteries in waterproof cases, with safety pins for attaching to the suits. And now their red glow guides the rescue ships to the sailors in time.

THE SOUND GOES ROUND AND ROUND

WINDING up words on a doughnut-sized spool, the new sound recorder being redesigned for mass production by General Electric under license from the Armour Research Foundation will eliminate the use of pencilled notes by observers on reconnaissance planes.

Sixty-six minutes of continuous speech can be reeled up on the 11,500 feet of thread-thin wire within the recorder's small box. Though employing much the same principle as the dictaphone, the observer's words are recorded magnetically on the wire, instead of being scratched into a wax cylinder.

When the recording has served its purpose, the words can be erased magnetically, and the wire is as good as new for future use. *General Electric Co., Schenectady, N.Y.*

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

GENERAL ELECTRIC

965-72-211

192,000 employees of the General Electric Company are on their jobs producing war goods and buying over a million dollars of War Bonds every week to hasten victory.

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